MAY 1957

# Power Engineering


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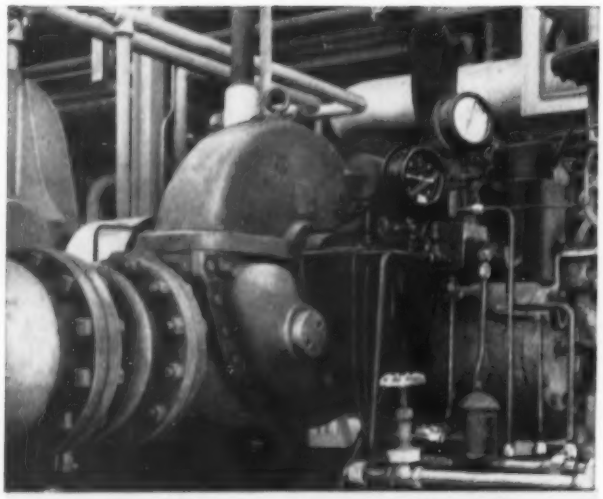
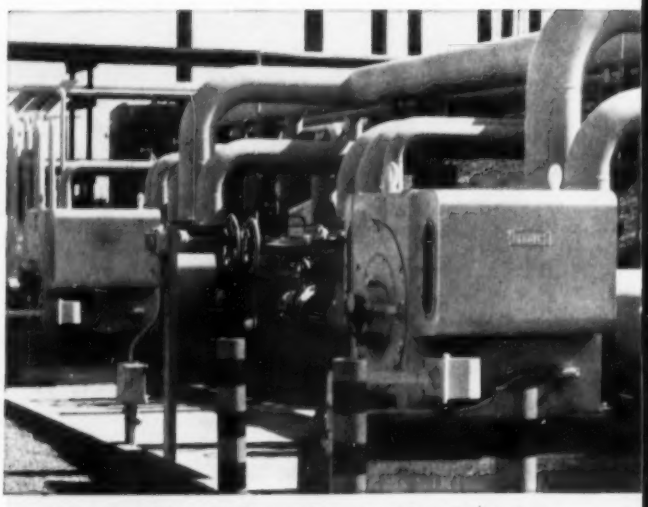
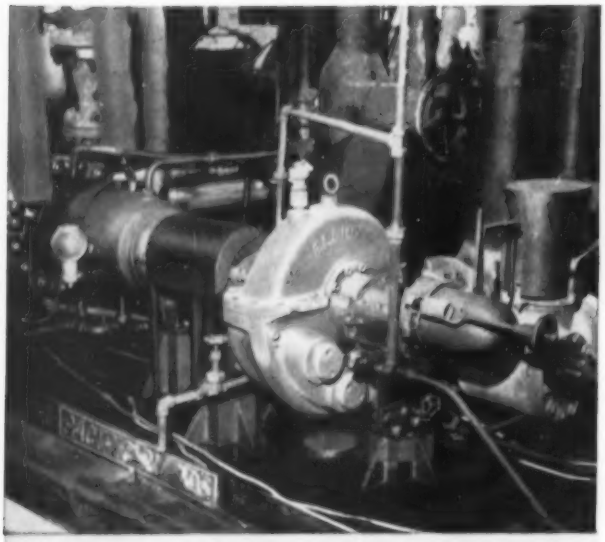
# ELLIOTT serves



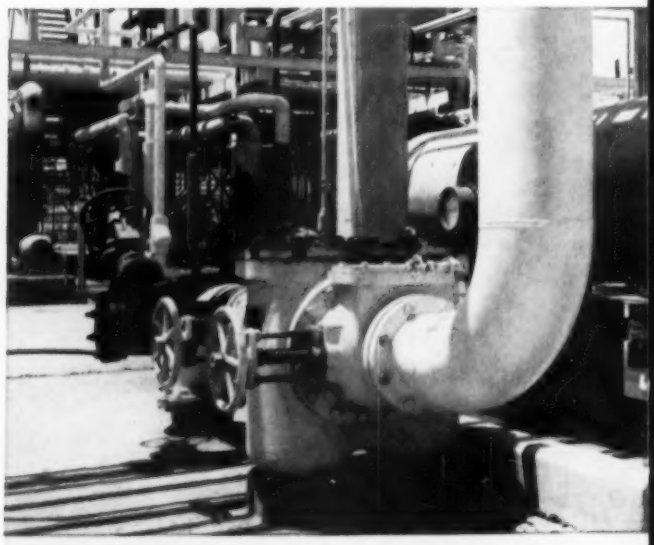
This Elliott 370-hp, 3240-rpm steam turbine drives a reciprocating compressor through a gear. The compressor serves a hydroformer unit.



These two Elliott 450-hp weather-protected outdoor motors, located in the bluff area near the docks, are used to drive centrifugal pumps which handle heavy naphtha from adjacent tankage.



One of eleven Elliott turbines driving centrifugal pumps at a lube oil unit.



Here an Elliott 8-in. twin strainer handles river water at a lube oil unit.

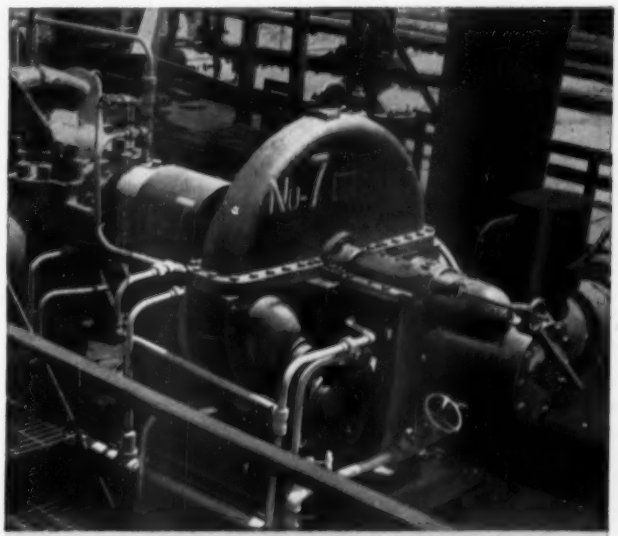
# ...most versatile refinery

## *Esso Standard's Baton Rouge Refinery—producing more products than any other—is served by Elliott Turbines, Motors, Twin Strainers, Steam Ejectors, Deaerating Heaters*

When this Esso Standard Oil Company refinery started operations in 1909, it processed 2000 barrels of crude oil per day into only three products. Now it converts 340,000 barrels of crude oil per day into over 600 products—a world's record in respect to number of products. It is also rated the largest refinery in the United States based on crude running capacity.

More than 100 Elliott steam turbines, ranging in size from 7 to 900 hp, are used in this refinery to drive all sorts of pumps, fans and compressors. Over a score of Elliott twin strainers, sizes 2 in. to 24 in., and Elliott steam jet ejectors serving vacuum units have been installed. Elliott 300-hp, 400-hp, and 450-hp motors are driving pumps and an Elliott 1750-hp, 1800-rpm induction motor is driving a centrifugal gas compressor. There are also four Elliott deaerating feedwater heaters.

Here is another dramatic illustration of how highest-quality steam and electrical products, manufactured by Elliott, serve leading industries. For information on how Elliott products can help you, call your nearby Elliott District Office or write Elliott Company, Jeannette, Pa.



***Elliott Turbines,* from small single-stage to large multi-stage types, assure highest-quality, long-term continuous service. This typical installation, operating on a 24-hour-a-day basis, is a 460-hp, 1750-rpm Elliott turbine which drives a river water booster pump. Bulletin H-228 describes the features which have resulted in the widespread use of Elliott YR turbines.**

**ELLIOTT Company**

Q7-1

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

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Sleeve bearings are a critical factor in the output of any continuously operating plant. An increase in temperature of **only 20°F** above 180°F cuts bearing life almost in half; hot-running bearings can lead to costly maintenance and downtime.

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS


# ENGINEERS' PREVIEW

**SINCE 1954, a research project to investigate Properties of Cast Iron at Elevated Temperatures has been in progress at Southern Research Institute under the sponsorship of the ASME-ASTM Joint Committee on Effects of Temperature on Properties of Metals. Objective of this work is to determine the suitability of cast-iron alloys for load-carrying applications in the temperature range 700 F to 1000 F. Following phases of work have been completed so far:**

**1, A literature survey of related work in this field; 2, Screening tests on twelve commercial cast-iron alloys; 3, Creep-rupture tests at 800 F and 1000 F on seven of the most promising alloys for times up to 5000 hours; 4, Thermal-shock tests on the same seven alloys.**

**Progress report, details of results and details of future work can be obtained from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Penna.**

AMERICAN INDUSTRY may have to revise its battle plans in the fight to relieve the current shortage of engineering talent. This is one conclusion drawn from the results of a survey published recently by The American Society of Mechanical Engineers. That survey, conducted at the annual meeting of ASME in New York last November and recently tabulated, indicates that the majority of the engineers who answered think that industry should put more emphasis on increasing the productivity of engineers already employed. This would be in addition to continuing efforts to increase the number of students graduated by engineering colleges each year.

In response to the question, "What measures do you think should be taken to end the shortage of engineering manpower?" 65 per cent of the answers suggested changes in current industrial practices.

In the order of frequency these steps dealt with:

1. Providing engineers employed in industry with more technical assistants and clerical help, thereby freeing professional men for more creative work. (31 per cent)

2. Increasing salaries to make the profession more attractive to youngsters and to qualified engineers who have been lured to other fields by higher pay. (21 per cent)

3. Improving the recognition and prestige accorded to engineers for their contributions to the economy. (12.5 per cent)

**POPULARLY-WRITTEN, illustrated booklet describing the national apprenticeship program has been released by the U. S. Department of Labor's Bureau of Apprenticeship. Titled Apprentice Training — An Investment In Manpower, this 32-page booklet explains in non-technical language the aims, organization, and operation of the national apprenticeship program.**

**Copies of the booklet may be obtained free of charge from the Publications Branch, Bureau of Apprenticeship, U. S. Department of Labor, Washington 25, D. C.**

IDEAS of free lance inventors are needed right away to help solve nine *blue sky* problems which baffle the armed services, according to the National Inventors Council, U. S. Department of Commerce.

A problem is *blue sky* when it will take imaginative, sky-is-the-limit thinking to solve it.

The Council is the official clearinghouse for all inventions of potential value to the government.

The nine revolutionary ideas needed by the armed services are: Non-magnetic Compass; Explosive Mine Detector; Method for Converting Light into Electrical Energy; Snow Track Eraser; Destructive Ray or Wave; Universal Track, Radical Method for Unloading Ships; Vehicle Black-out Devices; New Type of Communication. An ingenious new method of transmitting intelligence, non-detectable except by the desired receiver.

The military is seeking a new principle which does not use electrical impulses, electro-magnetic waves or sound waves.

Complete lists of hundreds of technical problems affecting the national defense may be obtained by writing NIC, U. S. Department of Commerce, Washington 25, D. C.

**REMEMBER that splendid, practical book entitled I Want To Know About The Electric Industry, which has been published for several years by the Edison Electric Institute? It gives detailed specific answers (with numbers in them) to 29 questions frequently asked the Institute, which is the trade association of electric companies in the U. S. A.**

**Now the Institute has just issued the 9th edition, 1957, of this 32-page booklet. It is particularly useful to all power engineers, not only in the utility field but also in any other field, for answering questions about our business that are frequently asked by non-engineers. We suggest you ask the Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y. for a copy of it.**

RESULTS OF experiments which, for the first time, make feasible the transmission of narrow band television pictures with motion over ordinary telephone cable pairs were revealed recently in a talk before the Franklin Institute of Philadelphia by C. Raymond Kraus, general staff transmission engineer of the Bell Telephone Co of Pennsylvania.

The new system utilizes standard telephone cable facilities for transmission and operates successfully up to distances of 10-15 miles. Further development work, Mr. Kraus indicated, could possibly extend the range of transmission even further. Although the pictures are not quite as good as those required in regular broadcast transmission, they are still good enough for a variety of industrial applications where picture quality is not of primary consideration. "Obviously," said Mr. Kraus, "in the remote viewing of the output of a steel rolling mill it is not necessary to be able to distinguish the ripple in the workman's overalls."

This new availability of telephone cables as TV signal carriers may

make use of television in industrial and institutional applications far more practical than ever before.

**ROCKWELL Manufacturing Co. has acquired the assets of Republic Flow Meters Co. of Chicago. Present management of Republic will remain unchanged, says W. F. Rockwell, Jr., president of Rockwell Manufacturing Company, with James D. Cunningham, founder of Republic, continuing as president. W. F. Crawford, president of Edward Valves, Inc., a Rockwell subsidiary, will be associated with the Republic management in Chicago.**

EFFECTIVE April, 1, W. H. & L. D. Betz changed from the partnership form to the corporate form. At the same time the company name was changed from W. H. & L. D. Betz to Betz Laboratories, Inc. But their address, Gillingham & Worth Streets, Philadelphia 24, Penna., remains unchanged.

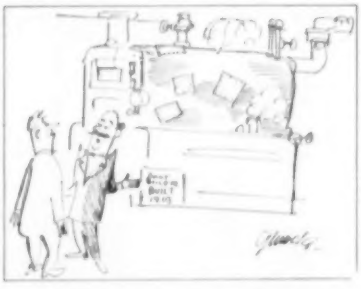
**CORPS OF ENGINEERS of the U. S. Army has placed the largest order for hydraulic turbines ever received by Allis-Chalmers Manufacturing Co for installation of seven units in the Oahe Reservoir project on the Missouri River near Pierre, S. Dak.**

**Each unit will be rated 128,500 hp under 185-ft head. When installed, the seven units will provide 900,000 additional horsepower to the west north central section of the country. It will mark another step in controlling the Missouri River. The first hydraulic unit is scheduled to be shipped in the spring of 1960. Completion is set for fall 1962.**

CENTRAL ILLINOIS Public Service Co has anounced that installation will begin early in 1958 of a new 200,000-kw generating unit at the company's Meredosia power station in northwest Morgan County. The unit, which will be CIPS' largest, is expected to be in operation by the summer of 1960. It will increase the company's generating capacity to 775,000 kw. Sargent & Lundy, Chicago, is engineering consultant. Contracts have been let to Allis Chalmers for the 200,000 kw turbine generator and to Combustion Engineering for boiler equipment.

**M. NIELSEN was elected president of the Babcock & Wilcox Co. on April 3. For the past two years he has been executive vice president of the company. He succeeds Alfred Iddles, who is retiring after serving as president since 1948. (Readers of POWER ENGINEERING, under its former title, *Power Plant Engineering*, will remember some of the fine articles on boiler operation and maintenance written by Mr. Iddles before he became president of B&W.)**

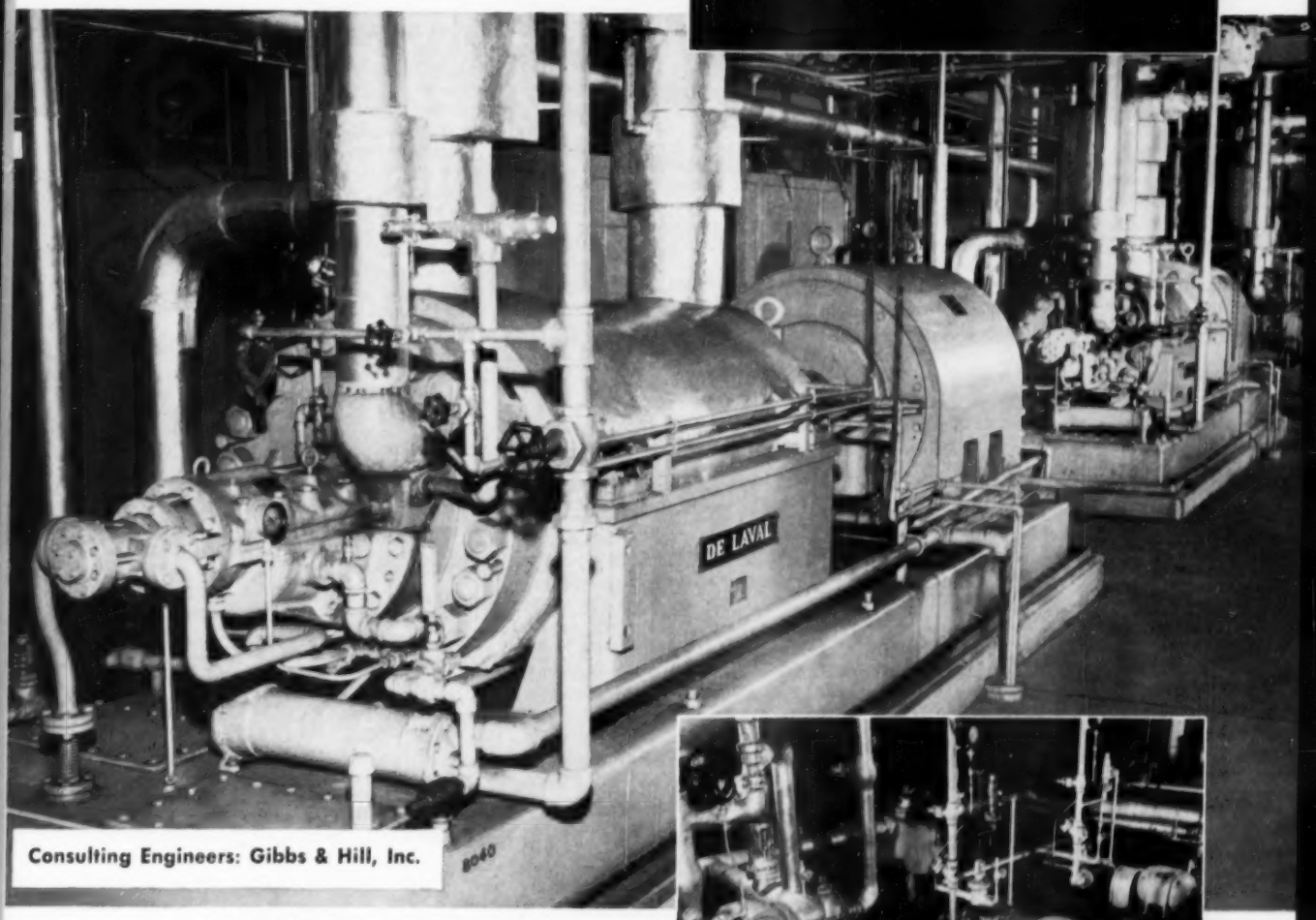
**To his new post as head of B&W, Mr. Nielsen brings 33 years of broad experience in the company. He joined it in 1924, in 5 years rose to Chicago district inspector, and in 1937 was made district erector in charge of the Cincinnati district. During World War II, he was superintendent of marine erection for the company. In 1947, moved up to production superintendent of the Barberton plant, and moved to New York in 1950 to become an executive assistant in charge of the contract department. In 1953 he became vice president in charge of all boiler division manufacturing, in 1955, executive vice president.**

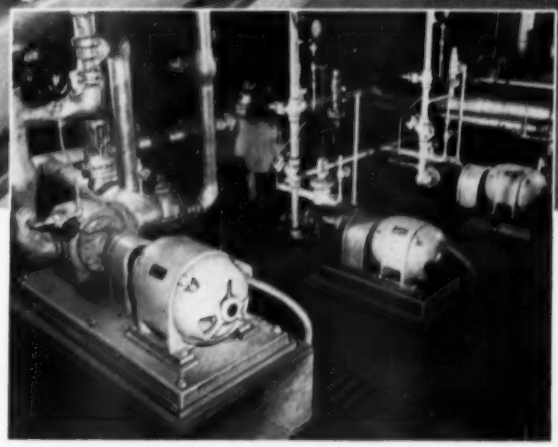


**"I wouldn't run it at its original rated pressure any more, however."**

# *Atlantic City Electric ... another utility using*

## DE LAVAL
### BARREL TYPE BOILER FEED PUMPS



De Laval IMO rotary positive displacement pumps handle heavy fuel oil. They are used for standby operation.

Atlantic City Electric Co. and Gibbs & Hill, Inc., Consulting Engineers, know that they can count on De Laval reliability. That's why they selected three De Laval high pressure barrel type boiler feed pumps for the Deepwater Station in Penns Grove, New Jersey. These 10-stage units deliver 675 gpm, operating at 1762 psi with temperature at 287 F. The pumps are driven by 900 hp motors.

De Laval barrel type boiler feed pumps operate at pressures up to 5500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting, only one inner high-pressure joint, and bare shaft construction. Their dependability is proven by year in, year out service in public utilities and industrial plants.

*Send for De Laval Bulletin 1506, which contains helpful data.*

**DE LAVAL** *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY
*816 Nottingham Way, Trenton 2, New Jersey*

DL-943

## WHAT THEY TELL US

▶ **REPLYING** to a letter asking about life expectancy of power equipment and percentages of amortization to allow, we can find no better information than the well-known book, Steam Power Stations, by the late G. A. Gaffert.

The percentages of amortization or depreciation, according to Mr. Gaffert, will in general vary between 2 and 6 per cent. That is just for this factor alone, entirely aside from any other of the fixed charges. Our own personal observation has been that nowadays, the rate used is closer to 5 or 6 per cent, in many cases, than it is to 2 per cent. There are obsolescence factors today that we didn't have in past years.

Furthermore, in the case of electric power utilities, their accounting systems are established on the basis of certain standards that have been set up by various commissions. In industrial and institutional types of plants, the depreciation rates are also affected a great deal by the accounting procedures used, but these are by no means as uniform as those used by the private utility companies. Then again, in municipal and state institutions, where the tax situation is entirely different, that also may affect the accounting procedure.

And as readers well know, there is always the problem of analyzing the actual physical life of the equipment as compared to its economic life. This comparison, however, is not so important in the case of the power house equipment unless it is in connection with introduction of new ideas like the supercritical unit or the atomic power plant. For most industrial and institutional types of work, the more conventional equipment must still be used, although even in these cases engineers should not overlook the value of a cost analysis on the older equipment.

▶ **OUR EDITOR'S** trip to Russia last summer continues to keep him busy giving talks on that strange but interesting country to various groups throughout the states. These groups include both civic and technical organizations. At an inter-club meeting in Quincy, Mich. recently, Andy's talk drew an audience of 175 guests.

The following note on this meeting was sent to us by C. D. McKenzie of the McKenzie Milling Co, at Quincy, who was in charge of the program:

> "Four Rotary Clubs — Quincy, Reading, Litchfield, and Jonesville — were represented at the inter-club dinner meeting at which Mr. Kramer delivered his address on the Soviet Union. Rotarians from Coldwater and Sturgess and members of the Quincy Lions Club also were present. Russia, in the opinion of Mr. Kramer, is not the Russia that most Americans visualize. According to the Chicago editor, Russia believes in education, has churches for those who wish to attend, excellent urban transportation systems, and many things of beauty. His many Kodachrome slides substantiated what he said about the country and its people."

▶ **ON ANY ARTICLE** dealing with power plant operating or maintenance problems, or on costs, we always get many comments from readers that we don't have space to publish. But we try to do so when these comments bring out additional and important technical information.

As a case in point, the article How We Instructed a New Steam Plant Crew by G. R. Setterlund, August 1956 issue, continues to arouse much interest. Here is a question about it from Reader C. T. Minnich of Nebraska, which we sent to the author:

> Your article in POWER ENGINEERING is very interesting to me as we are starting up a new plant away from our present location. An entire new crew will be trained from scratch, and we are hoping for the best. We gather you got along all right, under the same circumstances.
>
> Would you tell me how much time was required from the start of training to the first kilowatt turned out. We started training January 1, and hope to go on the line June 1, 1957.
>
> Our capability is 16,500 kw, 850 psi, 900 F total temperature attemperator control.

**SETTERLUND** gave Minnich the following information, not included in the original article:

> Our crews started to receive instruction, verbal and blackboard lecture, during the month of February. We were limited at this time to theory only, as the new plant was under construction. Instructor time was not available in excess, because key personnel were divided between operations of the old plant and erection of the new one. March 23 brought the operating crews to the plant site for actual orientation and instruction.
>
> By June the plant was far enough advanced for boiling out. During the boiling out period, hand operation was the order of the day. An additional two weeks was allowed for start-ups, blackouts and firing procedure. Control panels during this time were calibrated and paralleled as far as possible.
>
> Crews were then taught their specific duties: shift foreman, in complete charge of plant including feedwater treatment plant (split stream hydrogen and sodium zeolite type); auxiliaries inspection and lubrication; personnel control, and so on; firemen for control of boiler, boiler feed pumps; control panels, and one helper for coal and ash handling. By the end of June the unit was on the line on pulverized coal.
>
> Total practical instruction time was three months, excluding an additional two months of previous theoretical instruction. An additional two months of follow-up was required to iron out small bugs in equipment and operational data.
>
> I assume you have qualified personnel for instructors. You should have an experienced plant superintendent or foreman to coördinate training. Second, a qualified generator operator will be necessary. Then a boiler operator will be required. It would be ideal to have these three key men on each shift.
>
> If this is not possible, 16 hours-plus daily will do for actual start-up. I would suggest that the boiler operators and start-up men be allowed to experiment during the day and have the use of your coolest crew men. Have your key instructors work with the men at night during boiling out and test run periods. I do not know if commercial sources of coal are available, but I assume you are using gas, oil, or both. If coal is to be burned, more time is required than if gas or oil are being used.
>
> Auxiliary equipment will require careful instruction. This includes condenser, condensate pump, generator and turbine oil coolers, generator air cooler, deaerator, possibly an evaporator and condenser, and two or three more closed heaters and feed pumps. Operators must know what they are going to control. A generator operator should be able to operate after three months of instruction (if laws allow him to do so). Concentrated instruction will cut this time down.
>
> Feedwater treatment and control operations can be taught in a short time with proper equipment.
>
> Perhaps you have a plant available where each new crew man could serve with an operator of equal status. They need to become familiar with a generating plant, preferably of similar capabilities.

*One in a series.*

# How to Select a Steam Trap Big Enough for the Job

**Adequate capacity safety factors are essential to operating efficiency**

As promised to you in a previous Armstrong trap advertisement in this publication, here is some helpful information on steam trap safety factors.

First, the definition. A trap safety factor is simply the ratio between actual continuous discharge capacity of the trap and normal condensate load. If the load is 500 lb/hr and the trap actually will discharge at the rate of 1000 lb/hr, the safety factor is said to be 2 to 1, and so on.

### Why a Safety Factor?

You are not going to get maximum heat transfer efficiency from any steam heated unit unless your traps are sized with a generous excess of capacity over the normal condensate load.

Remember that trap capacity is given in terms of *continuous* discharge of condensate at a given pressure differential. If you don't employ an adequate safety factor, you make no provision for these requirements or conditions:

1. ***Venting of gas,*** $O_2$ and $CO_2$, would be impossible if a trap should discharge a full stream of water continuously.

2. ***Peak loads*** would back up condensate in the line or unit if the trap were sized for average load.

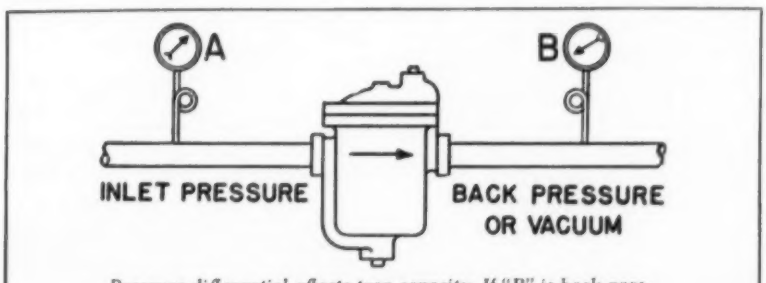
3. ***Reduction in pressure differential*** across the trap orifice would reduce capacity below requirements. If steam pressure drops below normal, trap capacity is lowered more than condensing rate. An increase in back pressure for any reason cuts trap capacity. And, pressure differentials often drop substantially during warming-up periods.

4. ***"Group" trapping.*** Very occasionally it is impractical to use an individual trap on each coil or condensing unit. Here, a generously oversized trap helps prevent backup of condensate or air from one unit to another. The frequent opening of a big trap valve "pumps" non-condensibles and condensate to the drain header.

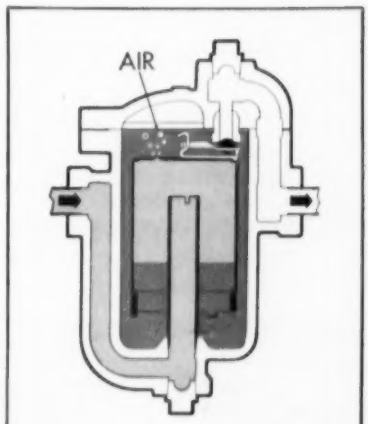
### What Safety Factor?

Fortunately, it isn't necessary to calculate safety factors. Experience is the best guide and the benefit of experience with tens of thousands of successful installations is available to you. The following table is taken from the Armstrong Steam Trap Book.

| Page | Equipment Drained | Safety Factors |
|---|---|---|
| 24 | Purifiers and Separators | 2 or 3 to 1 |
| 25 | Steam Mains or Headers | 2 or 3 to 1 |
| 26 | Steam Heating Pipes | 2 to 1 up to 6 to 1 |
| 29 | Unit Heaters | 3 to 1 |
| 30 | Submerged Coils | 2, 3 or 4 to 1 |
| 32 | Cylinder Dryers | 4 to 1 up to 10 to 1 |




*Pressure differential affects trap capacity. If "B" is back pressure, subtract from "A"; if "B" is vacuum, add to "A". Safety factors compensate for drops in pressure differential.*




*Traps vent air. This requires a trap capacity safety factor.*

The page numbers listed contain completely reliable data for any trapping job.

CAUTION. The safety factors recommended in The Armstrong Steam Trap Book will have to be increased by an unknown factor for trap capacity ratings based on cold water tests, orifice tests or slide rule calculations. Armstrong trap steam temperature condensate capacity ratings are based on actual operating conditions which take into account such capacity-reducing factors as pipe friction and the choking effect of flash steam.

If you'd like to have a copy of the 44-page Steam Trap Book, just call your local Armstrong Representative, or write the factory. There is no obligation.

**Armstrong Machine Works**
**8105 Maple Street**
**Three Rivers, Michigan**

**ARMSTRONG STEAM TRAPS**

**For more data circle 504 on Post Card**

■ The 16,000 users of YARWAY Blow-Off Valves include utilities, industrial plants, institutions and government installations—well-known plants and plants you've never heard of; large plants, small plants; with boilers of every pressure rating.

But there's one thing these companies have in common—*dependable blow-down service.* Their YARWAY Blow-Off Valves give them advanced engineering design, improved metallurgy, careful workmanship, exacting test standards and experienced field service.

On blow-off valves, *go* YARWAY—*with confidence.*

**UTILITIES**

Duke Power Co.
Boston Edison Co.
Consolidated Edison Co.
Connecticut Light & Power Co.
Eastern Shore Public Service Co.
San Antonio Public Service
Southwestern Public Service
Texas Power & Light Co.
Metropolitan Edison Co.
New Jersey Power & Light Co.
Northern States Power Co.
City of Los Angeles, Dept. of Water & Power
City of Pasadena Power Plant
Colorado Public Service Co.
Pacific Gas and Elec. Co.
Pacific Power & Light Co.
Southern Calif. Edison Co.
Washington Water Power Co.

**INDUSTRIALS**

Armco Steel Corp.
American Can Co.
American Viscose Co.
Armstrong Cork Co.
Atlantic Refining Co.
Bethlehem Steel Co.
Bigelow Sanford Carpet Co.
E. I. du Pont de Nemours & Co.
Eastman Kodak Co.
Jeddo-Highland Coal Co.

# YARWAY Blow-Off Valves are known by the companies

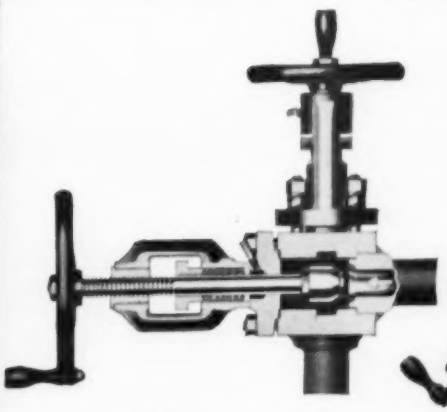
Hartford Electric Light Co.
Jersey Central Power & Light Co.
Penna. Power & Light Co.
Public Service Elec. & Gas Co. (N.J.)
Philadelphia Electric Co.
Virginia Electric & Power Co.
Alabama Power Co.
Arizona Public Service Co.
Dallas Power & Light Co.
Florida Power Co.
Georgia Power Co.
Gulf State Utilities Co.
Houston Light & Power Co.
Public Service Co. of Oklahoma
Central Illinois Public Service Co.
Cleveland Electric Illuminating Co.
Duquesne Light Co.
Indianapolis Power & Light Co.
Iowa Electric Light & Power Co.
Kansas City Power & Light Co.
Madison Gas & Elec. Co.
Nebraska Power Co.
Ohio-Edison Co.
Union Electric Co. of Missouri
Tennessee Valley Authority
Virginia Electric & Power Co.
Calif. Elec. Power Corp.
City of Burbank Power Plant
City of Glendale Power Plant
Lever Bros. Co.
Continental Can Co.
Dow Chemical Co.
Chesapeake & Ohio Railroad Co.
Aluminum Co. of America
American Bemberg Corp.
American Tobacco Co.
Celanese Corporation of America
Cities Service Oil Co.
Container Corp. of America
Humble Oil & Refining Co.
Phillips Petroleum Co.
R. J. Reynolds Tobacco Co.
Shell Oil Company
Southern Kraft Corporation

Goodyear Tire & Rubber Co.
Gulf Oil Co.
Hercules Powder Co.
Armour & Company
Buick Motor Co.
Carnegie-Illinois Steel Co.
Diamond Alkali Co.
Firestone Tire & Rubber Co.
Ford Motor Co.
International Harvester Co.
Monsanto Chemical Co.
Pittsburgh Plate Glass Co.
Procter & Gamble Co.
Standard Oil of Ohio
Republic Steel Co.
Tennessee Eastman Corp.
U. S. Steel Co.
American Potash & Chemical Corp.
Consolidated Mining & Smelting Co., Ltd.
Crown-Zellerbach Corporation
Fibreboard Products Co.

Metropolitan Housing Project (N.Y.)
New York Hospital
New York State Schools
Penna. State Sanatorium
Philadelphia Public Schools
Toronto General Hospital
U. S. Veterans' Hospitals
Worcester (Mass.) State Hospital
Florida State Hospital
Kentucky State Hospital
Louisiana State Hospital
North Carolina State Hospital
Oklahoma A & M College
Oklahoma State Reformatory
Oklahoma University

Oberlin College
Penna. State University
Purdue University
Somerset (Pa.) State Hospital
University of Chicago
University of Michigan
University of Wisconsin
Calif. Medical Facility
Mare Island Naval Shipyard
Oregon State College
Puget Sound Naval Shipyard
San Quentin State Prison
Soledad State Prison
U. S. Prison (Alcatraz)
University of Calif.

# they keep



Yarway Unit-Tandem Blow-Off Valve, hard-seat, seatless combination. One-piece forged-steel block serves as common body for both hard-seat blowing and seatless sealing valves. Hard-seat valve has integral, welded-in heavy stellite seat. Write for Bulletin B-434.

Yarway Seatless Blow-Off Valves, angle-straightway tandem. Note balance sliding plunger design. There is no seat to score, wear, clog or leak. Write for Bulletin B-426.

MacMillan & Bloedel, Ltd.
Pacific Lumber Co.
Richfield Oil Company
Standard Oil Co. of Calif.
Union Oil Co. of California
United Air Lines
Westinghouse Electric Co.
West Virginia Pulp & Paper Co.
Weyerhaeuser Timber Co.

**INSTITUTIONS AND GOVERNMENT**

Boston Public Schools
Harvard Medical School

Texas A & M College
Texas State Hospital
Texas Technical College
University of North Carolina
Carnegie Institute of Technology
Indiana State Reformatory
Iowa State College
Massillon (Ohio) State Hospital

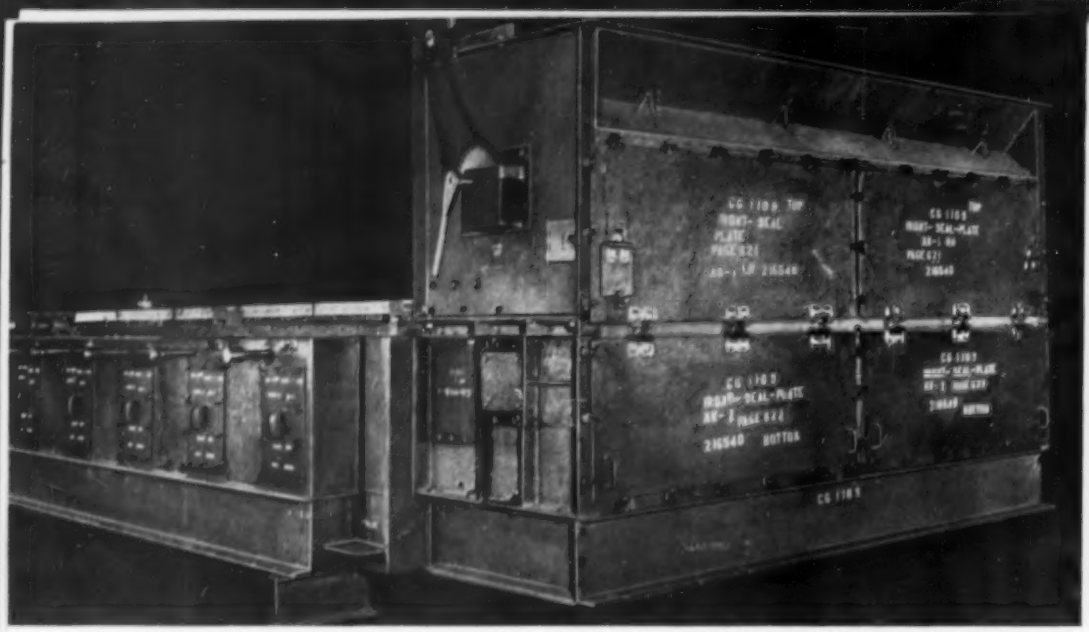
University of Idaho
Western Reg'l Lab. Dept. of Agriculture

**YARNALL-WARING COMPANY**
100 Mermaid Avenue
Philadelphia 18, Penna.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

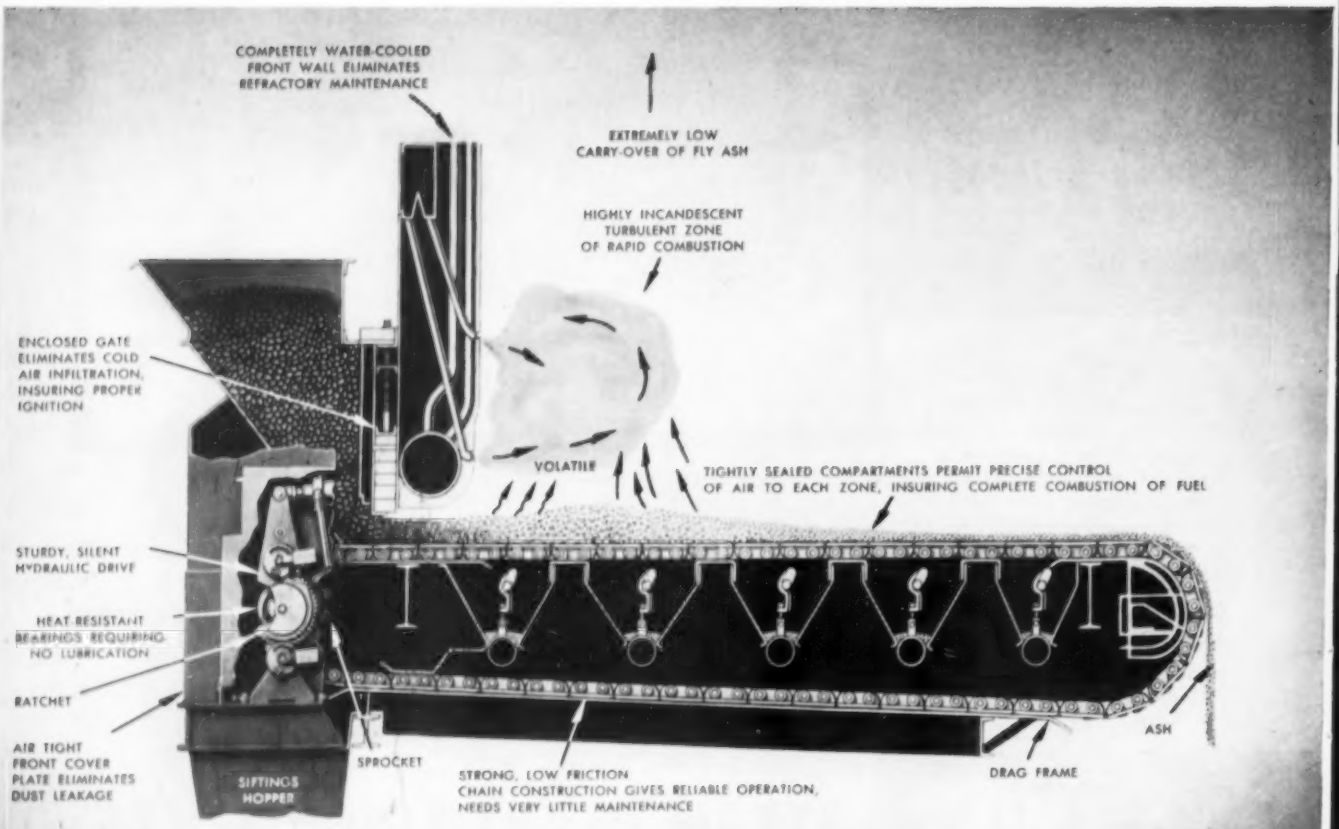
# STEAM PLANT EQUIPMENT

For more data circle 505 on Post Card

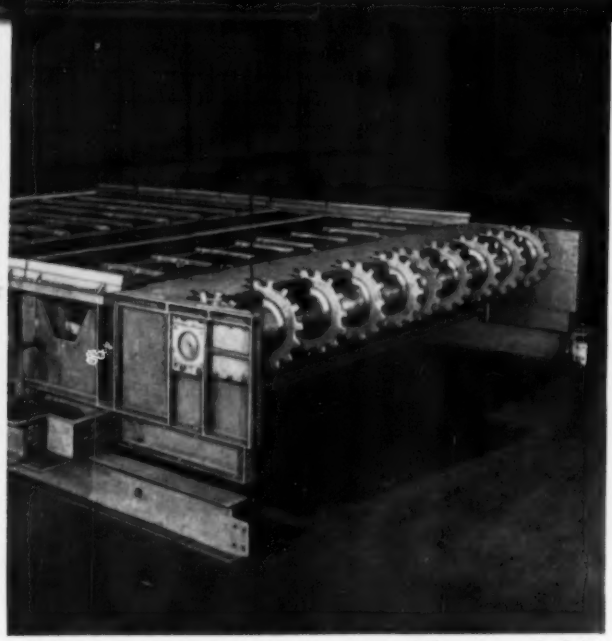


Front of unit is air and dust-tight, maintaining a clean stoker area. Note front seal plates.

# B&W Jet-Ignition Stoker Selected


COMPLETELY WATER-COOLED FRONT WALL ELIMINATES REFRACTORY MAINTENANCE
EXTREMELY LOW CARRY-OVER OF FLY ASH
HIGHLY INCANDESCENT TURBULENT ZONE OF RAPID COMBUSTION
ENCLOSED GATE ELIMINATES COLD AIR INFILTRATION, INSURING PROPER IGNITION
VOLATILE
TIGHTLY SEALED COMPARTMENTS PERMIT PRECISE CONTROL OF AIR TO EACH ZONE, INSURING COMPLETE COMBUSTION OF FUEL
STURDY, SILENT HYDRAULIC DRIVE
HEAT RESISTANT BEARINGS REQUIRING NO LUBRICATION
RATCHET
AIR TIGHT FRONT COVER PLATE ELIMINATES DUST LEAKAGE
SIFTINGS HOPPER
SPROCKET
STRONG, LOW FRICTION CHAIN CONSTRUCTION GIVES RELIABLE OPERATION, NEEDS VERY LITTLE MAINTENANCE
DRAG FRAME
ASH

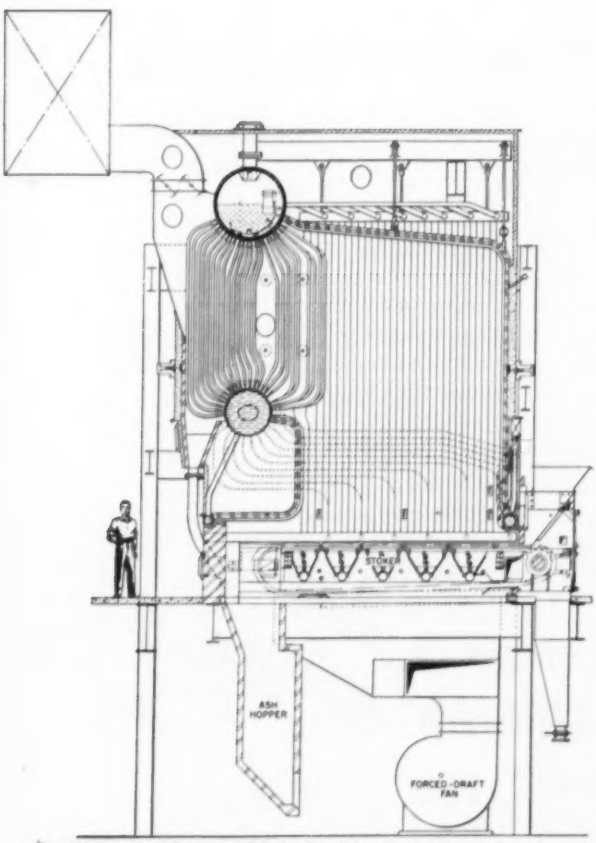
This is Jet-Ignition: Volatile matter, distilled off as coal enters furnace, is immediately mixed with high pressure air. Turbulence insures rapid combustion, radiates heat down on incoming fuel. Gate is completely enclosed, assuring ignition stability. Inspection is easy, maintenance low.



Jet-Ignition Stoker is designed on the chain-grate principle. It has simple, compact hydraulic drive.

## Latest Unit at University of Rochester Will Burn High-Caking Coals

# to Solve Smoke and Fly Ash Problems




B&W Stirling Boiler with Jet-Ignition Stoker at University of Rochester, designed for 100,000 lbs of steam per hr at 125 psi.

Stable, efficient combustion over wide load ranges, without smoke and with extremely low fly ash, is achieved by the new B&W Jet-Ignition Stoker when burning bituminous and sub-bituminous coals—including high-caking and coking grades. The Jet-Ignition Stoker maintains a clean stack without using dust collectors.

**Selection** of a B&W Jet-Ignition Stoker for the University of Rochester was made to solve a community relations problem caused by smoke and fly ash. Dr. Lewis D. Conta, Chairman of the University's Division of Engineering, and George D. Haas, Chief Engineer, recommended installation of the unit after observing a commercial installation burning the high-caking coals used by the University.

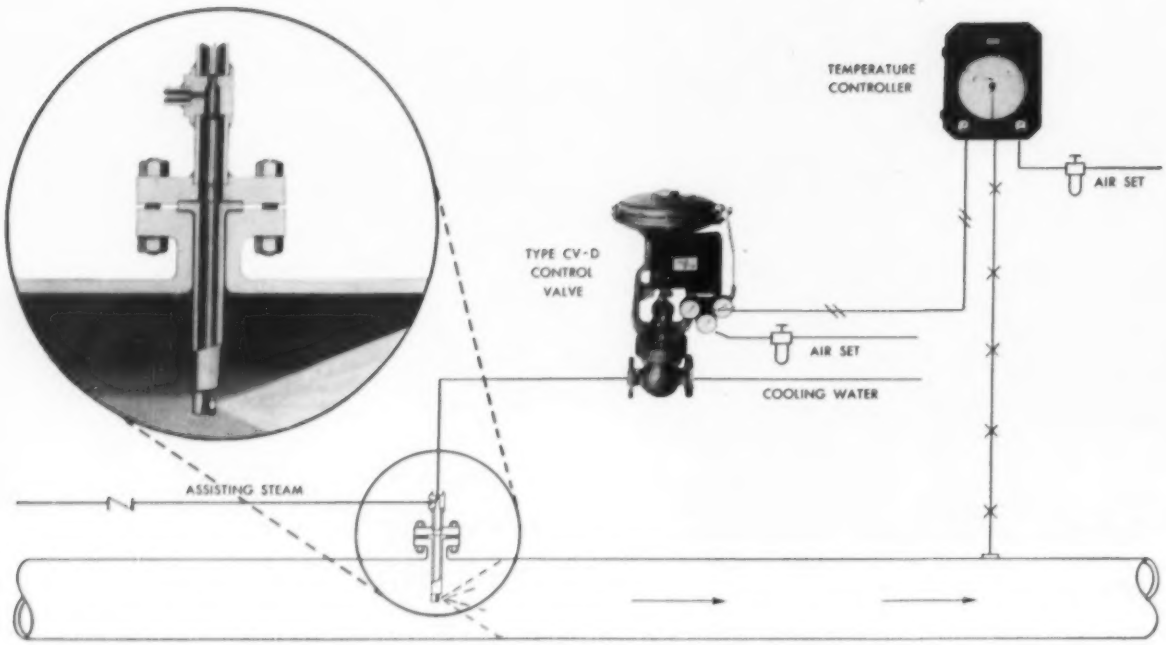
**B&W Jet-Ignition Stokers** are another of the developments of B&W engineering and research, supported by nearly a century of experience in all phases of steam generation. If your problem is one of excessive smoking and fly ash emission, Bulletin G-85 will tell you how a B&W Jet-Ignition Stoker can help you. And for any problem in steam generation, B&W engineers are ready to help you and your engineers find the solution. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-831-18

**BABCOCK & WILCOX**

BOILER DIVISION

For more data circle 506 on Post Card




Normal installation of a Copes-Vulcan Steam-Assist Desuperheater is shown schematically

# Get more accurate control with the NEW Copes-Vulcan Steam Assist Desuperheating Station!

Both carburetor and in-line types are available in the new Copes-Vulcan Steam-Assist Desuperheater

Here is a desuperheater based on a new, proven principle that delivers more accurate control of final steam temperature for process work or auxiliaries. It uses steam only on lighter loads. As load increases, the flow of assisting steam is automatically reduced—normally without an atomizing-steam valve. Assisting steam can be off completely at high loads where no more than mechanical atomization is needed. Control is close, even at 10 degrees above saturated temperature.

Cooling water and assisting steam are intimately mixed in the exclusive Swirl Chamber—upstream from the point of injection. No large steam bubbles form to cause annoying hammer or vibration.

Incorporated into the station for close modulating control of cooling water flow is the new Copes-Vulcan Type CV-D Valve. It is designed for the exact operating characteristics suited to your needs.

Enjoy the benefits of Copes-Vulcan desuperheating, custom-engineered for your individual requirements. Be sure of accurate control, minimum maintenance and long service life. Write for Bulletin 1024.

**COPES-VULCAN DIVISION**

**BLAW-KNOX COMPANY**

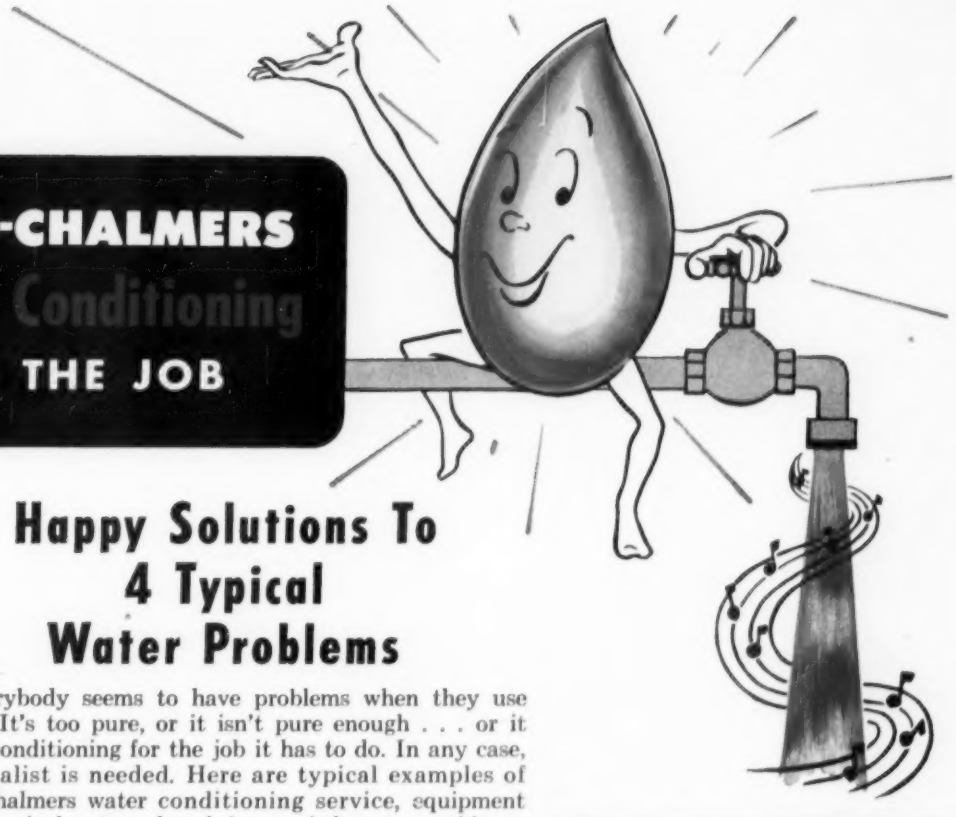
**ERIE 4, PENNSYLVANIA**

BLAW-KNOX

COPES VULCAN

For more data circle 507 on Post Card

**ALLIS-CHALMERS**
**Water Conditioning**
**ON THE JOB**



# Happy Solutions To 4 Typical Water Problems

● Everybody seems to have problems when they use water. It's too pure, or it isn't pure enough . . . or it needs conditioning for the job it has to do. In any case, a specialist is needed. Here are typical examples of Allis-Chalmers water conditioning service, equipment and chemicals at work solving varied water problems.

### Drought Adds to Woes of River Water Users

CALIFORNIA—Things looked bad at a paper company when the first water samples came in. In fact, one water conditioning company went so far as to say that the alkalinity of the water could never be reduced to a satisfactory level.

But on the assurance of Allis-Chalmers experts, a de-alkalizer was ordered for boiler make-up water.

In the meantime there was a drought. The drought made the river water conditions even worse than they had been, so that by the time the equipment was installed there was real trouble with alkali.

Allis-Chalmers engineers had an unusually tough problem on their hands. Instruction, experiment, on-the-spot service, and a program of constant control have resulted in production of satisfactory boiler make-up.

### Saved $60,000 in New Equipment

LOUISIANA—A low pressure industrial steam plant was being supplemented by a 1250-lb boiler. The question arose—can any of the old water conditioning system be used? Preliminary investigation indicated the need for demineralization equipment to get the desired water quality for make-up in the new equipment.

A survey of the records showed that it would be possible to use condensate from the low pressure system as make-up for the high pressure system. This solution of the problem required less modification of equipment than was originally anticipated . . . saved an estimated $60,000.

### Stained Glass Has Its Place, But Not in Nursery

ILLINOIS—A nursery was spraying water over the outside of its glass hothouses to control the temperature inside. The method was effective, but the iron stains from the water were troublesome. Allis-Chalmers water conditioning experts recommended A-C's 130 Series complexing agents. This did the job by preventing the iron from depositing on the glass.

### Battle with Algae Ends in Knockout

KENTUCKY—A petroleum company is finding out what a lethal weapon Allis-Chalmers new 120 Series algaecide really is. Previously they used sodium hypochlorite, but their cooling tower algae problems were not solved. Now they have complete control . . . using concentrations of only one-half of what is normally recommended. They also say it's easier to handle and apply, and better in every way, than anything they've ever used before.

### Get Help on Your Water Problems

Whether you need chemicals, equipment or service, Allis-Chalmers provides an unbiased recommendation based on over 25 years' experience. No problem is too big or too small. Specialists are located in many cities. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

**ALLIS-CHALMERS**

A-C ALLIS-CHALMERS A-5304

For more data circle 508 on Post Card

# A Beautiful

## NEW! MICRO-MOUNT




Fast and accurate mounting is made possible by the new Dodge Micro-Mount. The Adapter is snugged up with the Micro-Mount Nut. Mounting is completed by turning the Micro-Mount Screws against the Lockwasher until bearing, adapter and shaft form an integral unit.

Now — a spherical roller bearing pillow block has been added to "America's most complete line of mounted bearings."

This new Dodge product possesses all the fine characteristics of the spherical type, plus the precision, dependability and refinements you would expect from the nation's leading supplier of mounted bearings.

Rugged housing of close-grained semisteel, in compact modern design, withstands shock loads. The new Micro-Mount Adapter seats Spher-Align solidly on shaft, *with amazing ease and speed.* A new feature of bearing design allows lubricant to enter at center of bearing and move outwardly along all bearing surfaces. Convenient drain plugs permit use of either grease or oil and provide for easy flushing. Triple seals retain lubricant.

Standardized dimensions make Spher-Align interchangeable with all other similar units. Available in expansion and non-expansion types. In stock for 2 7/16" to 8" shafts. Call your Dodge Transmissioneer — or write us.

**DODGE MANUFACTURING CORPORATION • 6400 UNION ST., MISHAWAKA, INDIANA**

*New Bearing by Dodge —*

# Spher-Align

ANNOUNCING AMERICA'S NEWEST SPHERICAL ROLLER BEARING PILLOW BLOCK ...A RUGGED BEARING IN ATTRACTIVE MODERN DESIGN...INHERENTLY SELF-ALIGNING...EASY TO INSTALL...EASY TO MAINTAIN...AND FEATURING THE UNIQUE MICRO-MOUNT ADAPTER

**AMERICA'S MOST COMPLETE LINE OF MOUNTED BEARINGS**

**DODGE-TIMKEN**
*Tapered Roller*

**SPHER-ALIGN**
*Spherical Roller*

**SC, SCM, SL**
*Ball*

**SLEEVOIL**
*Precision Ring Oiling*

**BRONZOIL**
*Capillary Oiling*

**BABBITTED**
*Solid and Split*

***PILLOW BLOCKS • HANGER BEARINGS***
***FLANGE BEARINGS • UNIT MOUNTS • TAKE-UPS***

**DODGE**
*of Mishawaka, Ind.*

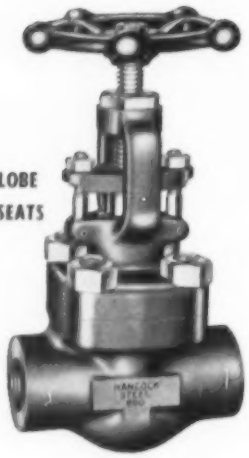
**CALL THE TRANSMISSIONEER,** your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in the yellow pages of your telephone directory—or write us.

**For more data circle 509 on Post Card**

# NEW 600# STEEL

**NEW**

**TYPE 5500 — 600# GLOBE**
**INTEGRAL HARD-FACED SEATS**
**"500 Brinell"**
**Stainless Steel Discs.**



Especially suitable for high pressure steam and temperature services in power plants. **Sizes:** ¼" thru 2". **Standard Materials:** Forged carbon steel A.S.T.M. A-105 Gr. II. **Alternate Body and Bonnet Materials:** 1¼% Chrome, ½% Moly Steel, A.S.T.M. A-182 Gr. F-11. **Connections:** Screwed and Socket Weld Ends. For all pressures up to 600 psi at 910°F. O.W.G. — 2000 psi at 100°F.

**NEW**

**TYPE 5520 — 600# GLOBE**
**TYPE 5530 — 600# ANGLE**
**RENEWABLE "300 BRINELL"**
**STAINLESS STEEL SEATS**
**"500 Brinell" Stainless Steel Plug Discs.**

Ideal for processing plants and general industrial service. **Sizes:** ¼" thru 2". **Standard Materials:** Forged carbon steel A.S.T.M. A-105 Gr. II. **Alternate Trims:** 18-8 Type 316 Stainless Steel; Monel. **Alternate Body and Bonnet Materials:** 5% Chrome, ½% Moly Steel, A.S.T.M. A-182 Gr. F-5; 18-8 Type 304 Stainless Steel A.S.T.M. A-182 Gr. F-304. **Connections:** Screwed, Socket Weld and Flanged Ends. **Screwed and Socket Weld Valves:** For all pressures up to 600 psi at 910°F. O.W.G. — 2000 psi at 100°F. **Flanged Valves:** For all pressures up to 600 psi at 850°F. O.W.G. — 1440 psi at 100°F.

These 600# bolted bonnet forged steel valves really make sense to every man who knows the economy of quality valves. Designed into them are plus values that substantially reduce profit-draining production shut-downs, maintenance problems and inventory costs. Built as companions to the widely-used Type 950 Hancock 800# Steel Gate Valves, they offer:

*Thick, Rigid Body and Bonnet Flanges* that can withstand more than ten times the rated pressure of the valve. The flanges butt — no bending, no distortion.

*Re-usable Flexitallic Bonnet Gasket,* in combination with the rigid body and bonnet flanges, prevents bonnet joint leakage. The gasket is a spiral-wound ribbon of stainless steel with asbestos filler and spring-like compressibility. It rests in a groove in the body flange — cannot blow out even if pressures exceed ten times the rating of the valve. *Hancock 600# Steel Valves are the first globe valves to use this important feature.*

*Maximum Use of Stainless Steel.* Even the stem, swing bolts, nuts, thread bushings and packing gland followers are stainless steel — your assurance of quality that saves throughout the long life of these valves.

The 5500 Line of Hancock 600# Steel Valves is available in Globe, Angle, "Flocontrol," Lift Check and Hi-Pressure Drop designs. Whatever your needs, you can buy these valves with complete confidence in their functional perfection. Like all other Hancock Valves, they are precision engineered and carefully manu-

**HANCOCK VALVES**

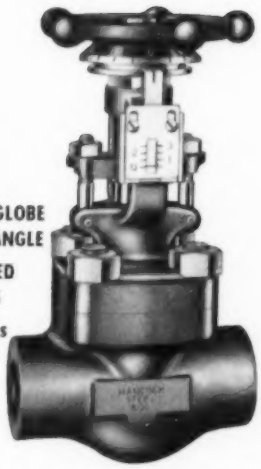
**PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR.** His broad knowledge and experience can be of real value to you. Let him help you select the right Hancock Bronze and Steel Valves for all your service requirements.

H1-67

# HANCOCK VALVES

**NEW**

**"FLOCONTROL"**
**TYPE 5525 — 600# GLOBE**
**TYPE 5535 — 600# ANGLE**
**RENEWABLE HARD-FACED STAINLESS STEEL SEATS**
**"500 Brinell" Stainless Steel V-Port Discs.**



For general industrial service. Variable orifice, shut-off and index combined in a single valve. Any desired setting can be instantly duplicated. **Sizes:** ¼" thru 2". **Standard Materials:** Forged carbon steel. **Connections:** Screwed, Socket Weld and Flanged Ends. **Screwed and Socket Weld Valves:** For all pressures up to 600 psi at 910°F. O.W.G. – 2000 psi at 100°F. **Flanged Valves:** For all pressures up to 600 psi at 850°F. O.W.G. – 1440 psi at 100°F.

**NEW**

**HI-PRESSURE DROP**
**TYPE 5505 — 600# ANGLE**
**INTEGRAL HARD-FACED SEATS**
**Stainless Steel Tube.**

An orifice type valve, with shut-off and index in a single unit that permits the use of a smaller valve with a large capacity. Designed to withstand the terrific wrecking power of continuous blow-down. Also for use on feed-water, by-pass relief, in turbine washing processes, and where erosion is extremely severe. **Size:** 1". **Standard Materials:** Forged carbon steel. **Connections:** Screwed and Socket Weld Ends. For all pressures up to 600 psi at 910°F. O.W.G. – 2000 psi at 100°F. A.S.M.E. maximum boiler pressure 970 psi.

factured. You can be sure of long resistance to wire drawing, galling, steam cutting, erosion and corrosion – for leakproof tightness month after month. They surpass the toughest service demands of process and power piping systems in the most modern refineries, petrochemical, power and industrial plants. A high degree of standardization in all sizes simplifies both maintenance and inventory needs.

Let the durability, performance and economy of Hancock 600# Steel Valves save money for you. Whether you are adding facilities, building a new plant or setting up a revalving program, get all the reasons why these tough valves serve better and longer. Complete information is yours on request.

***When Hancocks go in, valve costs go down***

**NEW**

**LIFT CHECK VALVE**
**TYPE 5540 — 600# GLOBE**
**RENEWABLE HARD-FACED STAINLESS STEEL SEATS**
**"500 Brinell" Stainless Steel Piston Discs.**

For general industrial service. **Sizes:** ¼" thru 2". **Standard Materials:** Forged carbon steel. **Cap:** Bolted. **Connections:** Screwed, Socket Weld and Flanged Ends. **Screwed and Socket Weld Valves:** For all pressures up to 600 psi at 910°F. O.W.G. – 2000 psi at 100°F. **Flanged Valves:** For all pressures up to 600 psi at 850°F. O.W.G. – 1440 psi at 100°F.

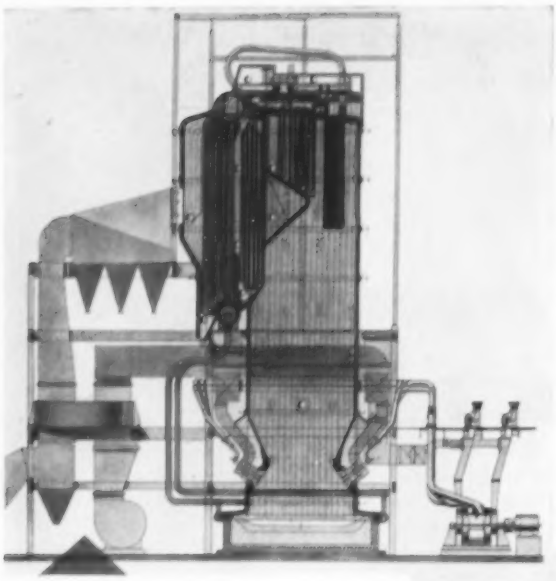
**A PRODUCT OF MANNING, MAXWELL & MOORE, INC.**

**WATERTOWN 72, MASSACHUSETTS**

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, California.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Michigan.*

***In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario***

**For more data circle 510 on Post Card**



# You get FREE RILEY

We mean by "Fuel Insurance" simply that the Riley TURBO FURNACE is designed to burn the "worst" fuel that can be anticipated. Low volatile *Fluid Coke**, for example, is burned with ease in the TURBO FURNACE; high ash, low fusion temperature *coals* are efficiently burned . . . and without slagging difficulties. Complete combustion of a high moisture fuel

Delaware Power and Light Co. will burn the Fluid Coke from the new Tidewater Oil Flying "A" Refinery in three 500,000 lbs/hr Riley TURBO FURNACE Units. Refinery Gas, Oil, Coal will be standby fuels. C. F. Braun & Co., Engineers and Contractors

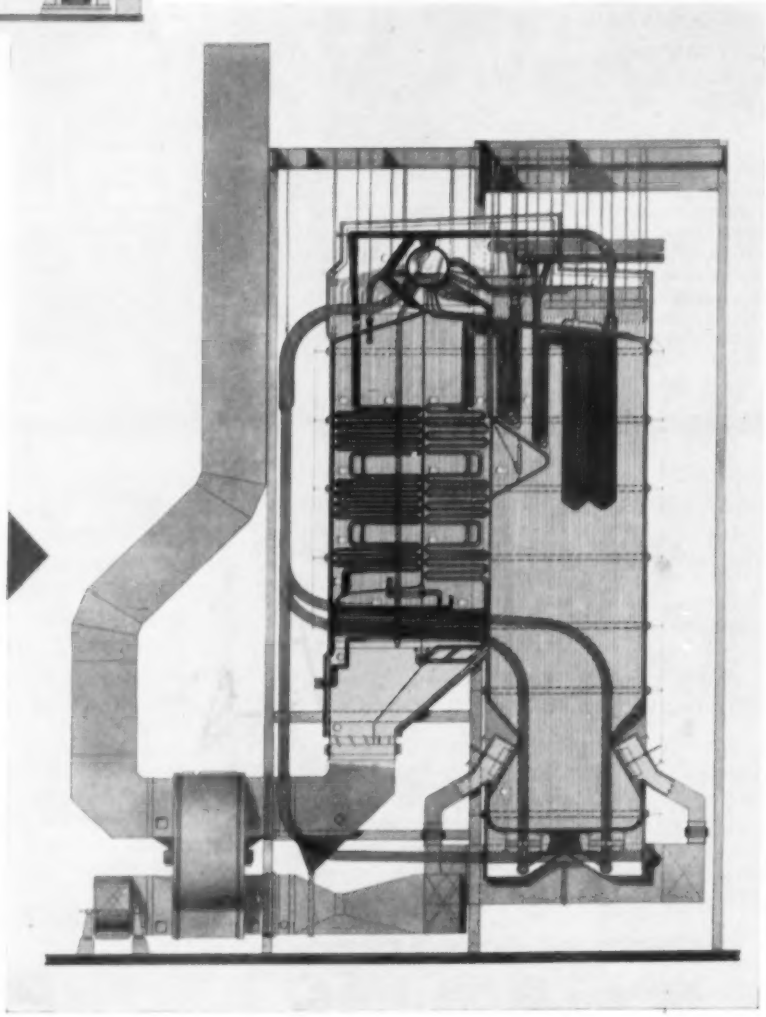
* *Fluid Coke*, is an extremely hard almost pure carbon by-product of the most recent development in catalytic cracking. *To burn effectively* a furnace is needed that provides high heat concentration after being reduced to required fineness by special Riley Pulverizers.

★ ★ ★

Louisiana Power and Light Co. will burn natural gas in its 1,550,000 lbs/hr Riley Reheat TURBO FURNACE Unit—it can quickly utilize oil, coal, lignite, refinery coke when economically justified.
Ebasco Services, Inc., Engineers

★ ★ ★

The TURBO FURNACE is enjoying rapid acceptance. It was formally introduced in the Fall of 1955 following extensive operation of actual installations that thoroughly established Riley's claims for its performance and design. Since then, thirteen TURBO FURNACE units have been sold to public utilities and large industrial companies. The total steaming capacity of these thirteen boilers exceeds 8,000,000 lbs/hr.



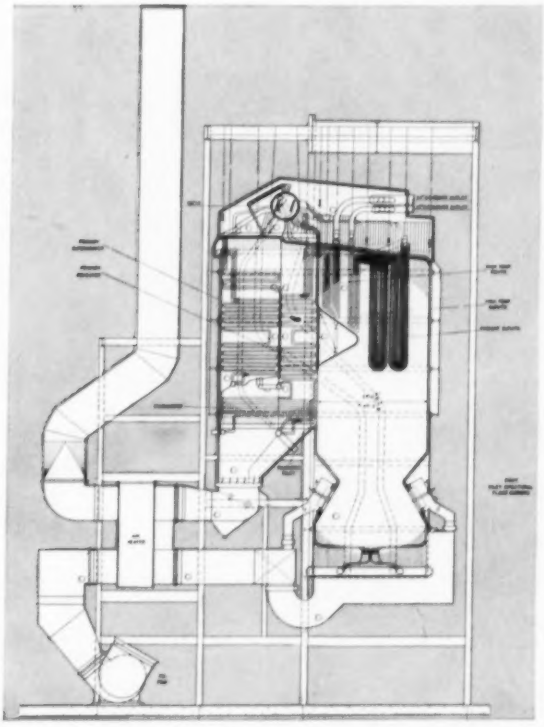
***RILEY DESIGNS, MANUFACTURES AND INSTALLS COMPLETE STEAM GENERATING UNITS AND FUEL BURNING EQUIPMENT FOR PUBLIC UTILITY AND INDUSTRIAL POWER PLANTS***

# FUEL INSURANCE with the TURBO FURNACE

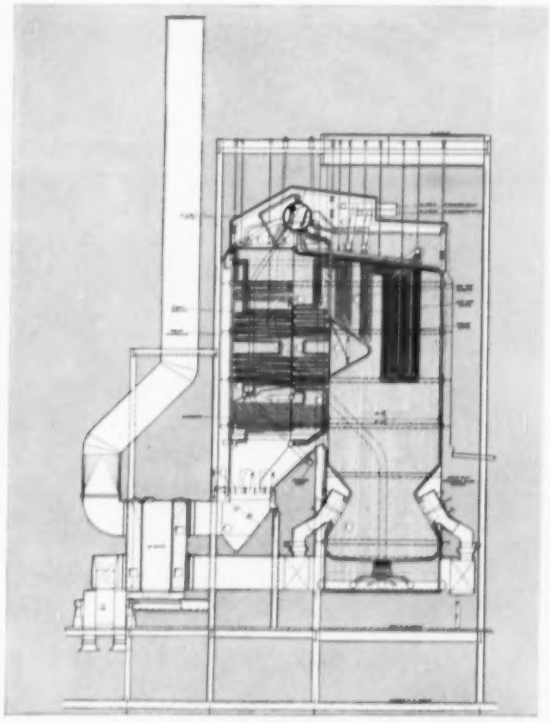
such as *lignite* is accomplished in the high temperature and turbulence of the combustion zone; the TURBO FURNACE not only utilizes *gas* and *oil* efficiently, but offers the quickest and least costly means by which to convert from *gas or oil* to solid fuels.

There is no premium for TURBO FURNACE "Fuel Insurance" . . . it is competitively priced.

Its "extra dividends" include clean furnace walls without the use of wall deslaggers, negligible combustible losses, elimination of the problem of fly ash disposal, lower overall height of unit, one level burner operation and the elimination of burner refractory and its maintenance. Write for complete details to Riley Stoker Corporation, Worcester, Mass.



Dallas Power & Light Company will burn natural gas and oil. Texas Lignite in the future in this 1,250,000 lbs/hr Reheat Unit. Ebasco Services, Inc., Engineers.



Texas Electric Service Co. will burn natural gas and oil in this 825,000 lbs/hr Reheat Unit. It can quickly convert to pulverized coal. Ebasco Services, Inc., Engineers.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

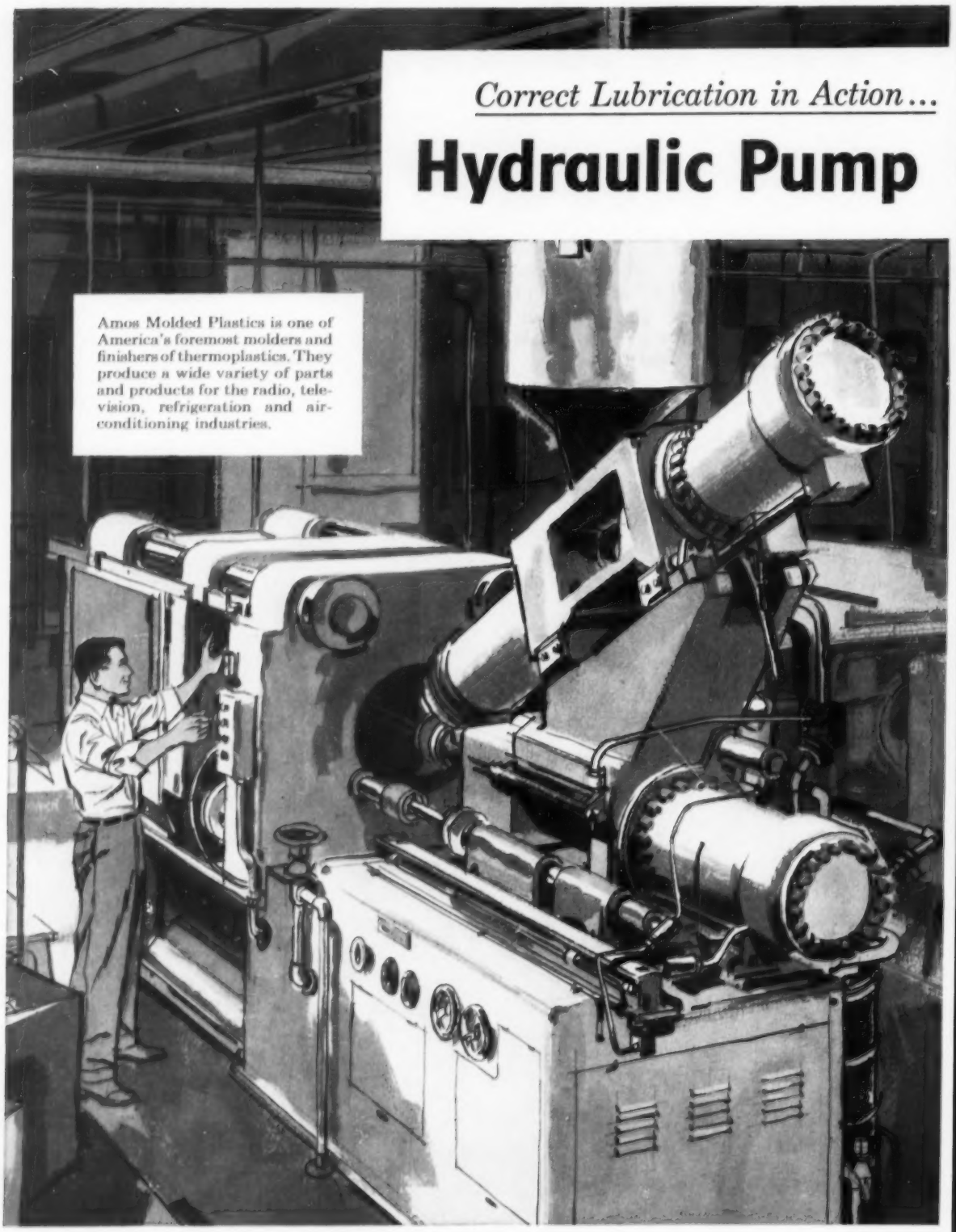
**RILEY**
*Stoker Corporation*
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

**For more data circle 511 on Post Card**

*Correct Lubrication in Action...*

# Hydraulic Pump



Amos Molded Plastics is one of America's foremost molders and finishers of thermoplastics. They produce a wide variety of parts and products for the radio, television, refrigeration and air-conditioning industries.

Mobil **SOCONY MOBIL**

*Leader in lubrication for over 91 years*

*in the* **Plastics Industry**

# Maintenance Cost Cut 44%

**One of many maintenance savings achieved for Amos Molded Plastics with the help of Socony Mobil**

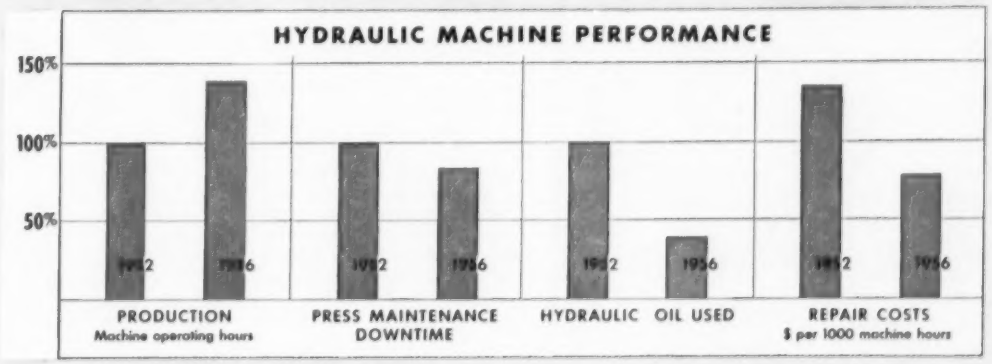
Despite a 37% increase in production hours over a five-year period, Amos Molded Plastics has managed to reduce maintenance and production costs consistently. This leading plastics manufacturer credits Socony Mobil's program of Correct Lubrication with a good share of these savings.

*To illustrate:* Records show that in 1952 molding machine hydraulic pump repair costs ran $135 per 1000 operating hours. Mobil engineers, working closely with the plant engineer, analyzed maintenance procedures . . . suggested improvements. They helped set up lubrication schedules for each machine . . . recommended the correct Mobil product for all equipment. Today, in spite of higher labor and parts costs, repair expenditures have been cut to $76 per 1000 operating hours . . . a reduction of 44%.

*This is Correct Lubrication in Action*—the only program that gives you the benefit of 91 years of lubrication knowledge . . . the services of more experienced lubrication engineers . . . top-quality products. It cut costs for Amos Plastics. Why not for you?

**How Correct Lubrication Cuts Maintenance Costs**

Graph shown here gives an accurate picture of results achieved for Amos Plastics through Mobil Correct Lubrication. Some ways this remarkable record was accomplished are detailed below.




**Machine downtime cut**—Excessive downtime of molding machines was found to be due to oil leakage and oil contamination. Mobil engineers recommended improved oil seals . . . set up periodic laboratory analyses . . . proposed annual cleaning of hydraulic systems. This cut downtime 17% . . . saved $13,800 over 1952 figures.

**Oil consumption cut sharply**—Socony Mobil maintenance clinics, conducted for plant's hydraulic engineers, taught them latest methods of reducing leakage. In addition, because Mobil hydraulic oils are of top quality they can be reprocessed and used indefinitely. Result—oil use was reduced 63% . . . $4,600 saved yearly.

These savings and many more helped Amos Molded Plastics increase profits. For information on how Mobil Correct Lubrication can cut costs, improve production, contact your Mobil representative.

*Correct Lubrication*

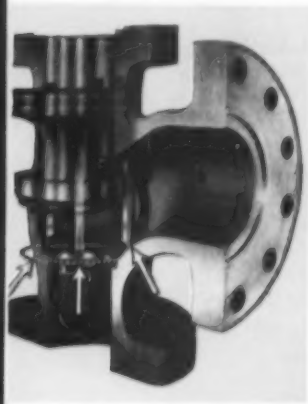
**A proved program to reduce maintenance costs**

SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP., MOBIL OVERSEAS OIL CO., INC.

**For more data circle 512 on Post Card**

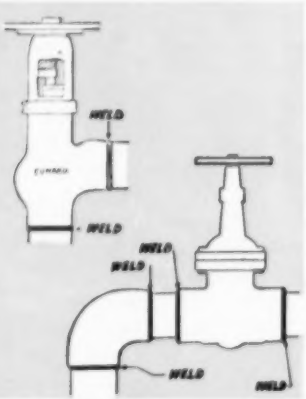
# How To Get The Most

## *Tips on selection, installation and operation of steel*



### INTERNALLY-GUIDED VALVES MORE EFFICIENT

Internally-guided stop, check, and non-return valves are more efficient if the disk centers into the seat for positive shut-off. Illustration shows typical Edward check valve with three integral guide ribs.




### ANGLE VALVES REDUCE INSTALLATION COST

An angle stop valve can often be used instead of an elbow and a globe or gate valve. This reduces installation cost, makes bends, elbows and other components unnecessary, minimizes pressure drop.

### STREAMLINING CUTS FLOW RESISTANCE

Internal streamlining, carefully designed and executed, cuts turbulence . . . reduces pressure drop . . . minimizes wear. Working with experimental half-models and the most modern laboratory equipment, Edward scientists incorporate the most precise streamlining in every valve.

### BACKSEAT ISOLATES PACKING CHAMBER

Stop, non-return and blow-off valves can actually be repacked under pressure if they have a positive backseat, as illustrated. Here, a radiused disk nut contacts beveled bonnet seating surface, isolates packing from line pressure. This feature also protects packing, and reduces maintenance.

### WELDED BONNET CAN'T LEAK

Ideal for severe service applications, small forged valves with welded bonnets are virtually leak-proof. This construction permanently maintains pressure tightness—eliminates need to periodically restress bolts. Weld can be removed, however, if internal repairs are ever necessary.

### HERE'S BEST WAY TO BLOW DOWN

To begin blow-down, open wide the valve nearest boiler—then open second valve. To stop blow-down, reverse procedure by closing second valve first—then close valve nearest boiler. This puts greatest wear on second valve, which can be repaired or replaced *without shutting down boiler.*

**Rockwell-Built Edward Valves**

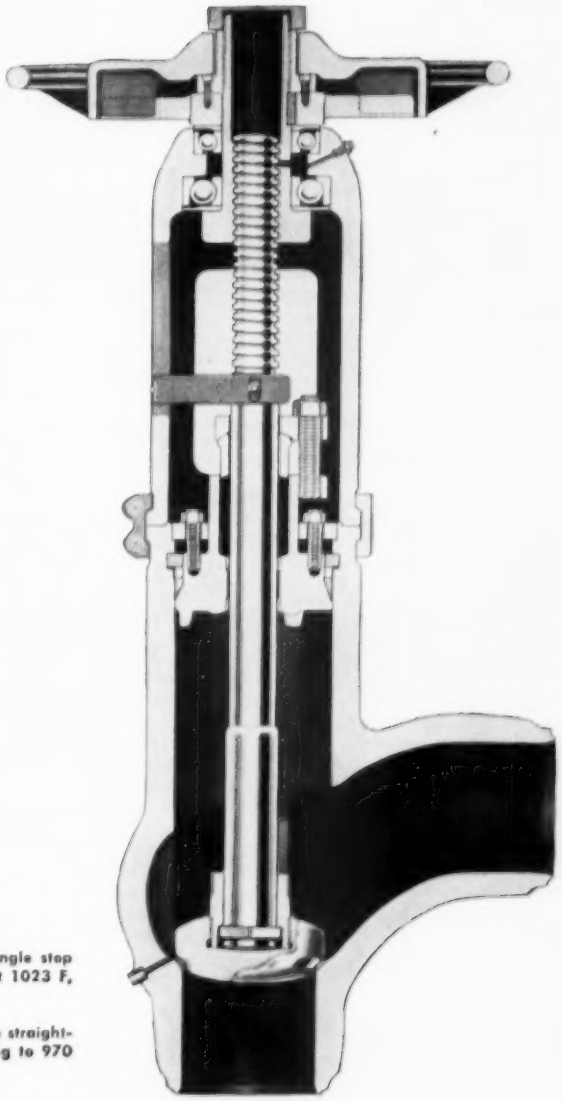
# Value From Steel Valves

## valves from Edward, long-time leader in the field

One way to cut the cost of initial installation—and future maintenance expense—of a piping system is to select the *right* steel valves. A competent valve engineer, for example, can often indicate where one angle stop valve can replace both an elbow and a globe or gate valve . . . reducing the costs of installation *and* cutting the number of piping components required. Other typical "secrets" of obtaining greater value from steel valves are shown in convenient clip-out form on the opposite page.

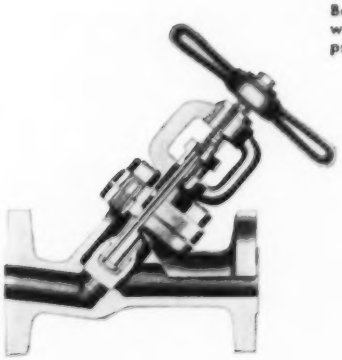
While he is well acquainted with piping conditions, a valve engineer concerns himself primarily with valves and their functions—and in this field, he is an acknowledged expert. His field experience, plus access to the results of continuous laboratory research, can put at your disposal a wealth of information on valve selection, installation, operation, maintenance and repair.

Such a man is your Edward Valve Representative. Technically trained, thoroughly experienced, his professional advice can save you headaches and money. At his disposal and yours are the results of continuing substantial investments in steel valve research. Many features, now accepted as standard in valves, were actually introduced by Edward. This process of constant development is reflected in Edward Valves . . . and in the spirit of your Edward Representative! He is at your disposal, to help you obtain the *most* for your valve dollar—both now and in the future. A card or a call will bring him . . . why not get in touch with us now?



Right: Fig. 7317Y cast steel 1500 lb angle stop valve for steam services to 1500 psi at 1023 F, water to 3600 psi at 100 F.

Below left: Fig. 641 forged steel 600 lb straightway blow-off valve for boilers operating to 970 psi saturated drum pressure.



**Edward Valves, Inc.**

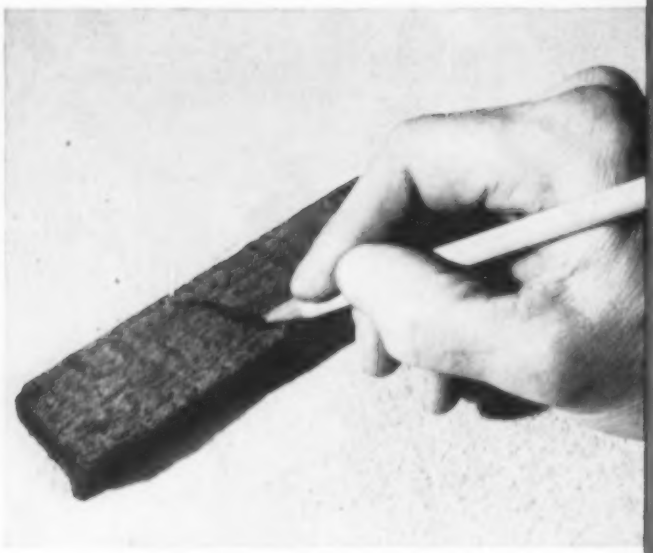
*Subsidiary of* ROCKWELL MANUFACTURING COMPANY

1202 WEST 145TH STREET

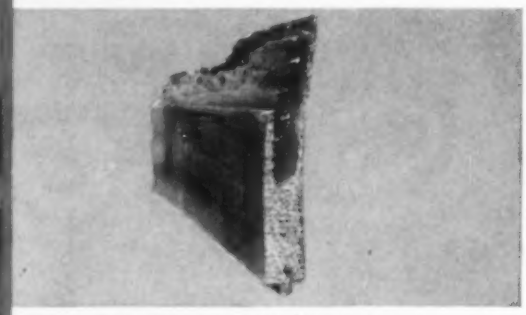
EAST CHICAGO, INDIANA

# Why Cooling Towers Fall Apart

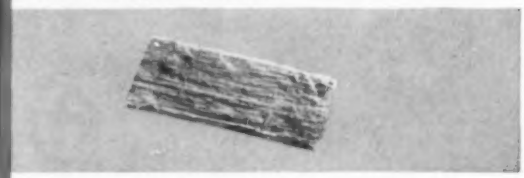
*...and how to prevent it!*



**SURFACE DETERIORATION** of cooling tower lumber sample has softened wood so that an ordinary pencil gouges it deeply.



**INTERNAL ATTACK** by fungus gives no warning of impending collapse. Outer wood surface looks perfectly sound.



**CHEMICAL LEACHING** from chemicals in water weakens wood, dissolves wood components that resist attack by fungi and bacteria.

**Cooling towers often almost literally commit suicide because efficient cooling sets up ideal conditions for deterioration of the best woods used in their construction.**

**WHAT HAPPENS?** Warmth and moisture present in cooling towers are perfect for microbiological growth . . . specifically, the bacteria and fungi which destroy wood. Cooling tower lumber is naturally resistant to these organisms — until the flow of water, containing chemicals either naturally present or added for slime, algae, scale or corrosion control, leaches out the materials which provide this resistance.

Some microbiological growths destroy the cellulose which gives wood its structural strength. Others remove the lignin that is a binder of wood's components. Either way, or both, mean expensive trouble . . . worse if the attacking fungi cause internal decay which can easily go undetected until too late to take protective measures.

## PREVENTIVE PROGRAMS

Since cooling towers function with piping and other equipment which must be protected from slime, scale and corrosion, it is evident that measures taken to prevent wood rot and leaching should not interfere with other system treatments — and vice versa.

This is Nalco's cue to enter the picture. The Nalco System takes *all* phases of protection into consideration . . . applies treatments that are compatible with each other . . . and with the cost accounts. A phone call or letter will bring the best efforts of the world's largest water treatment organization to bear on your problems.

★ ★ ★

*A magazine article "Why Cooling Towers Decay," goes into detail on the subject. Is available as Nalco Reprint No. 58. Your copy free on request.*

**NATIONAL ALUMINATE CORPORATION**
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THE *Nalco*® SYSTEM . . . SERVING WORLD INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

WATER TREATMENT . . . PAPER MILL PROCESS CHEMICALS . . . REFINERY CORROSION CONTROL . . . ION EXCHANGE . . . WEED & BRUSH CONTROL . . . SLIME & ALGAE CONTROL . . . PROCESS ANTIFOAMS & COAGULANTS . . . PETROLEUM CATALYSTS . . . COMBUSTION CATALYSTS . . . FUEL OIL STABILIZATION . . . CHEMICAL INTERMEDIATES . . . CONSULTING SERVICES

For more data circle 514 on Post Card

# HELPFUL BULLETINS

## MECHANICAL POWER TRANSMISSION

**101 Speed Reducer Data** — Bulletin 1105 combines in one 24-pp book complete information on company's concentric shaft and right angle speed reducers for applications up to 140 hp (up to 72,000 lb-in. output torque). Ratings are given, as well as dimensions, overhung load and thrust capacities. Horsepower selection tables show readily: standard output speeds obtainable with commonly used input speeds, and full range of hp ratings available for each standard output speed. Application pictures are also provided. The Falk Corp.

**102 Speed Reducers** — Catalog SCD-57, 8 pp, covers shaft-mounted Screw King speed reducers for screw conveyor application. By using data provided, selection of a complete drive can be made readily. Design details of the drive are discussed, and dimensional drawings included. The American Pulley Co.

**103 Magnetic Drives** — Data on design, drive features, operating and performance curves, output torque rating-dimensions, selection chart, as well as photos of installations and applications are included in 6-pp Bulletin W-T 1-57. Whitney Chain Co.

## LUBRICATION

**104 On Large Displacement Lubricators** — Complete instructions for servicing and operating large displacement lubricators actuated by a moving machine element are included in this service instruction sheet. Large photos of the vertical unit, closed filter unit and horizontal unit types are shown, as well as 16 types of meter-units. Specification tables included. Bijur Lubricating Corp.

**105 Automatic Gear Spraying** — Versatal gear spray equipment designed to accomplish a dangerous lubrication problem with safety and with a saving of up to 80 per cent of gear lubricant — with no machine shut-down — is described in this 6-pp bulletin. Drawings illustrate proper way to assemble gear spray units. Alemite Div., Stewart-Warner Corp.

**106 Improved Lube Fitting** — Bulletin BU-61 describes and illustrates advantages of a special relief-type lubrication fitting which can be attached to bearing housings of motors, machines or pillow blocks equipped with conventional relief plugs. Photos and drawings show how this fitting saves time and helps prevent over-lubrication. Keystone Lubricating Co.

## PUMPS, COMPRESSORS

**108 Rotary Gear Pumps** — How to solve pumping problems with rotary gear pumps is explained in this 36-pp catalog, once again made available to power engineers. Includes a general explanation of rotary gear pumps and discusses factors of pumping problems. Sample problems are presented, along with conclusions. Technical data section covers friction loss in hose, friction loss in pipes, friction loss through fittings, cylinder displacements, viscosity crankcase oils, viscosity fuel oils, viscosity conversion chart, viscosities and specific gravity of common liquids, and other data. Geo. D. Roper Corp.

**109 Piston Pumps** — Bulletin 9900-A, 8 pp, describes vertical and horizontal "Oil-Rite" reciprocating pumps designed for a variety of high pressure installations (up to 1000 psi and 35 gpm). Contains performance tables, dimensions, construction features and lists of accessory equipment. The Deming Co.

**110 Simple Little Pump** — This 8-pp bulletin describes the Magnaflow, a fractional horsepower, centrifugal pump of extremely simple design and great versatility. Explains how the pump works, what it does and where it's used, including a list of more than 40 fluids handled. Component parts are illustrated. Also provided are capacity data, maintenance and installation tips. The Corley Co., Inc.

**111 Deep Well Pumps** — Bulletin 4701-D describes an expanded line of Minuturb turbine pumps that deliver more than 100 gpm from deep wells. Presents construction features and performance data. These pumps are for service where more than the normal water supply is required. The Deming Co.

**112 Sewage Pumps** — Twelve-pp Bulletin 7500 illustrates heavy-duty wet and dry pit sewage pumps, small vertical sewage pumps and standard and submersible cellar drainers. Includes performance tables for selecting pumps, dimensional drawings and details of construction. Also lists available control equipment. The Deming Co.

**113 Pumps and Pump-Motors** — Catalog 957, 12 pp, describes and illustrates the complete line of company's products and shows specifications in compact tabulated form. Text covers rotary pumps and hydraulic pump-motors, fully amplified with photos, drawings and diagrams. Geo. D. Roper Corp.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 113 and 114.

**114 Air Compressors** — This 20-pp catalog on air compressors covers ½- to 20-hp models for industrial and other uses. Well illustrated, gives complete specifications on single- and two-stage models, portable models, tanks, pumps and accessories. Charts, engineering data and data on compressed air are included. Kellogg Div., American Brake Shoe Co.

## SAFETY AND FIRE PROTECTION

**115 Protecting Power Equipment** — "Corrosion Control for Electric Light and Power Equipment" is an illustrated semi-technical brochure containing recommendations for application of paint products to this type of equipment. Transmission towers, substations, woven fire fencing, transformers, smoke stacks are treated in detail, with recommendations for corrosion-resistant paint maintenance. James B. Sipe and Co.

**116 Fire Protection Planning** — This 12-pp booklet deals with the planning of fire protection for structures and equipment associated with power generation and transmission. Discusses needs for such protection in power plants, switchyards and substations. Information provided also applies to transformers and similar electrical installations in industrial plants. A feature is an application chart covering water spray, mechanical foam, carbon dioxide, and dry chemical systems. Chart gives characteristics of each system with regard to special requirements of each type of equipment and flammable material. Automatic Sprinkler Corp. of America.

## VALVES, PIPING, FITTINGS

**117 Air Control Valves** — Sixteen-pp Catalog 105 describes a new line of pilot operated poppet-type air control valves manufactured by the company. Contains complete dimension, installation, application and operation data in an easy to use form, and describes features of the valves in detail. Photos, drawings and dimensional diagrams are included. Galland-Henning Nopak Div.

**118 Steam Pressure Valve** — Bulletin 981 describes company's Standard Type 44 pilot operated pressure reducing and regulating valve — a piston operated, single seat valve for accurate pressure control of steam under varying load conditions Information includes photo and cross-sectional diagram of the valve, specifications, pressure and temperature ratings, capacity chart, installation instructions and other data. A. W. Cash Co.

**119 Hydraulic Pilot Valve** — This catalog sheet describes company's spring loaded, diaphragm actuated hydraulic pilot valve. Contains photos, cutaway diagrams, descriptions of valve features and recommended applications and specification instructions. Atlas Valve Co.

**120 Float Valves** — Sixteen-pp Bulletin W-5 explains features of company's cushioned float valves designed to maintain accurate water level control in elevated tanks, coagulating basins, mixing chambers. They are for cold or hot water service in quick opening or throttling design. Parts list, dimensions, and shipping weights are given for the various sizes. Operation and installation data are included. Golden-Anderson Valve Specialty Co.

**121 Liquid-Gas Separation** — Bulletin S-1052, 10 pp, describes a liquid-gas separation device for removing entrained liquids and solids from air, gas and steam systems. Operation and construction features are detailed and complete specifications given. Illustrated with photos and cutaway views, bulletin also pictures and describes applications of the units. Sclas Corp. of America.

**122 Pressure Tubing** — This bulletin describes characteristics and installa-

tion advantages of flexible polyamide tubing, along with available sizes and information on where to use it. Also included are pictures and operating instructions for installation tools, such as the flaring tool and tube cutter, tube bending clips and a heat bending tool for fixed radial bends. The Polymer Corp. of Pennsylvania.

**123 Hose Clamps, Fittings** — Twelve-pp Form 300RG presents company's standard type hose clamps, grooved hose fittings, and special tools and replacement parts. It also serves as an instruction and training manual. Separate sections are devoted to detailed coverage of such subjects as Punch-Lok method, uses and applications, how to apply clamps. Punch-Lok Co.

**124 Flexible Connectors** — Bulletin 158 offers information on how to absorb vibration, dampen noise, reduce piping failure, and prevent leakage with these flexible connectors. Material specifications, pipe sizes, and fitting connections are shown as well as operating pressures and maximum off-set allowed. Installation diagram is also included. Flexonics Corp.

**125 Fixtures, Supplies** — This 8-pp illustrated catalog describes Globe fixtures used in installing plumbing, heating, air conditioning and sprinkler systems. Application and size data are provided. Products shown include steel inserts to hang overhead piping in concrete, split ring hangers, I-beam clamps and retaining rings, underground hanger clamps, steel ceiling plates, swivel hangers, escutcheon plates for sprinkler heads, others. Huppower Div., Hupp Corp.

**126 Pipe Fittings** — This 8-pp brochure describes a self-sealing pipe fitting designed to eliminate pipe connection leaks. A three-step diagram shows how the fitting is installed. In addition to covering uses and applications of the fitting, bulletin contains questionnaire concerning ideal specifications for such a fitting. Those who answer this questionnaire and send it to company will receive tabulated results. Tru-Seal Div. Flick-Reedy Corp.

## WATER TREATING

**127 Pressure Filters** — Publication 6321 describes company's standard Type C vertical pressure filters for commercial buildings, institutions, and small industrial plants. These filters serve to remove suspended matter, turbidity, dirt, rust, oil and color commonly found in surface waters. Operation details, sizes and filtering capacities given. Cochrane Corp.

**128 Why Deaerators** — Bulletin 102-A, 8 pp, describes advantages and applications of company's stainless steel deaerators. Discusses need for water deaeration in boilers, feed pumps and piping, and covers operating principles of the deaerator. A cutaway photo of the entire unit, plus a close-up detail drawing of the stainless-steel head section, trace the path of water from entrance to storage in deaerator tank. L • A Water Softener Co.

## ELECTRICAL

**129 Secondary Substations** — Twenty-pp Bulletin 9004-A describes secondary unit substations designed for economy in installation and operation indoors or outdoors. Advantages of the equipment are detailed. Separate sections are devoted to incoming line section primary devices incorporated, transformer section, outgoing section secondary switchgear, and several systems are presented. Application tables and guide specifications for secondary unit substations are provided. Booklet is illustrated with photos, diagrams. I-T-E Circuit Breaker Co.

**130 Drum and Cam Switches** — Bulletin GEA-6307A, 8 pp, covers drum and cam switches for manual and automatic control of wound-rotor, squirrel cage, d-c series, and compound-wound motors. Describes features of the units; lists continuous operation requirements; discusses various applications of drum and cam switches; and provides dimensions and selection data. General Electric Co.

**131 Specialty Transformers** — Bulletin GEC 1432 gives application tips, prices, dimensional data and model numbers on a line of quiet Type M transformers, 600 v and below, 60 cycles. These are designed for commercial buildings, institutions and other installations in densely populated locations. General Electric Co.

**132 On Autotransformers** — Bulletin GEC-1433 gives application pointers; prices, dimensions and model numbers; and selection data on dry-tape specialty transformers, single- and three-phase, 50 and 60 cycles, for boosting or bucking voltage on three-phase circuits in indoor or outdoor service. Includes connection diagrams. General Electric Co.

**133 Electrical Connectors** — Eight-pp Bulletin 637 introduces the Pyle-Star line of compact, lightweight and environmental-resistant electrical connectors for industrial and other applications. Electrical capacities and other data are given for the plugs and receptacles, claimed impervious to water, moisture, oil, gas, dust pressure, vibration and shock. The Pyle-National Co.

**134 Solenoids, Coils, Components** — This 8-pp catalog gives in complete detail, pictures and diagrams with pertinent information on solenoids, coils and electrical components. Typical applications are enumerated and special features described. Anderson Controls, Inc.

**135 Diesel Batteries** — Bulletin GB-1078B describes the Kathanode diesel locomotive starting battery that has been engineered to fill the heavy power requirements needed in diesel starting. It gives full details of battery construction, as well as complete specifications, with ampere-hour capacities, unit dimensions and approximate battery weights. Connecting diagrams and application for various models of diesel locomotives are also given. Gould-National Batteries, Inc.

## LIGHTING

**136 On Fluorescent Lighting** — Prepared for commercial and industrial users of fluorescent lamps, this 24-pp booklet features sections on general advantages of fluorescent lighting, development of fluorescence, and includes chapters on each of the lamp types, starters, lampholders, ballasts, and special lamps. Cites five major advantages of fluorescent lighting. Pictures, sketches and charts supplement the text. Sylvania Electric Products Inc.

**137 Lighting Unit Specifications** — The 1957 edition of the "RLM Standard Specifications for Industrial Lighting Units" contains important revisions in specifications on both incandescent and fluorescent units, as well as new lighting data. Of special importance are new coefficient of utilization tables for eight units. Calculations are based on latest zonal method of computing coefficients of utilization and illumination on room surfaces. Also included are revised light distribution curves on RLM direct and semi-direct fluorescent units, popularly called "upward light." Candlepower distribution curves are plotted at normal, parallel and 45 deg. RLM Standards Institute.

**138 Incandescent Lamp Manual** — This 24-pp incandescent lighting guide book covers more than 1,800 types and sizes of incandescent lamps. It features sections on characteristics of incandescent lamps, structure, a discussion of its filaments, bulb sizes, glass types and finishes, types of lamp bases. A special section states performance characteristics, with detailed but simple charts and graphs. Major types of incandescent lamps are discussed and illustrated, and maintenance and servicing are also covered. Sylvania Electric Products Inc.

**139 Industrial Lighting** — Illustrated solutions to common industrial lighting problems are presented in this 50-pp catalog, which shows how lighting was used to boost production in quality and quantity, improve worker morale and reduce number of accidents. In each of the typical installations pictured, estimated hourly cost a footcandle for each 10,000 sq ft is given, along with other data. Large Lamp Dept., General Electric Co.

## INSTRUMENTS AND CONTROLS

**140 Control Centers** — Electronic control centers, a new concept in automatic temperature control, are illustrated and described in 8-pp, full-color Booklet F 8031. Discusses functions, uses and advantages of centralized automatic control with visual supervision of entire heating and air conditioning system. Barber-Colman Co.

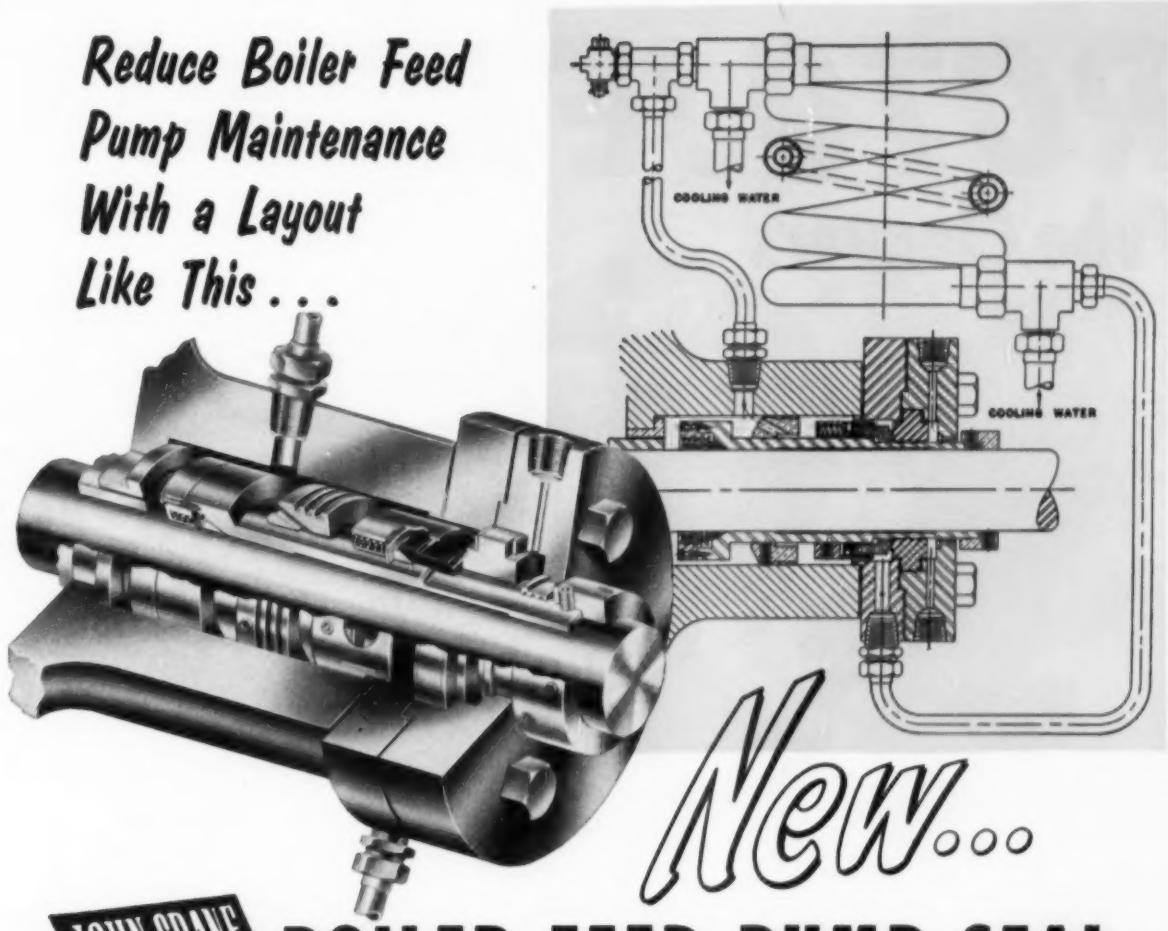
**141 Indicating Controllers** — Catalong C $\frac{600}{700}$ 1, 8 pp, describes company's small-case indicating pneumatic controllers for temperature and pressure. Specifications common to both temperature and pressure controllers, as well as individual specification, are included. Photos, drawings and ordering information also given. Industrial Div., Minneapolis-Honeywell Regulator Co.

**142 Instruments, Relays** — Bulletin 3042 is an 8-pp condensed catalog covering electronic components, temperature monitoring systems, and others. Provides application suggestions and specifications. Also includes data on stock model time delay relays. Instrument Div., Thomas A. Edison, Inc.

**143 Level Alarms, Controls** — Many standard applications for Magnetrols are illustrated and described briefly in this bulletin. They include boiler water level control, pump control, high or low level alarm and shutdown, others. Specifications and price data are provided for two models of extended float cage units, and brief descriptive information is given for several others in the line. Meters and Controls, Inc.

**144 Temperature Control** — How to automatically control building temperatures from outdoors is described in Bulletin P-257. Points out that economical and comfortable heating can be obtained only

# Reduce Boiler Feed Pump Maintenance With a Layout Like This . . .




# New . . .

# JOHN CRANE BOILER FEED PUMP SEAL

**You get cost savings in four ways:**

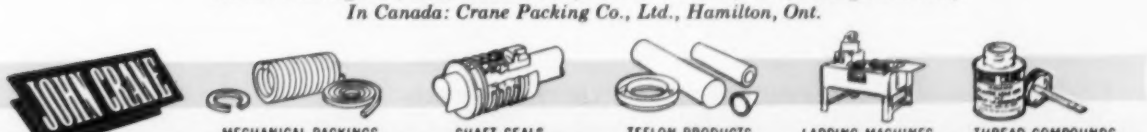
1. Replacement costs and "down time" are reduced. Service life is much longer than with other sealing methods.
2. Maintenance expenses are reduced. Once installed, the seal needs no further attention. Costly replacement of expensive sleeves is eliminated.
3. Long seal life—special closed circulating system provides cooling water in sealing chamber for best seal performance.
4. There is no leakage. Loss of valuable feed water is eliminated.

**You get 4-way job-engineered performance:**

1. "John Crane" engineers the seal to your operation. This includes adaption to your pump design and piping arrangement.
2. You are furnished with carefully drawn up plans. All necessary recommendations are supplied. Heat exchanger size is specified.
3. Package design provides easy installation and removal of seal without major pump dismantling—can be installed as readily in existing equipment as in new pumps.
4. "John Crane's" world-wide service organization and experienced engineering staff stand behind your installation.

***Now is the time to investigate this new boiler feed pump seal. Write for new illustrated technical bulletin.***

Crane Packing Co., 6429 Oakton St., Morton Grove, Ill. (Chicago Suburb).
*In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*




**CRANE PACKING COMPANY**

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# ROTOJET®
## Tube Cleaners

**Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY**

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.

**Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.**

ROTOJET Junior Model 532 Air-driven Motor, universal joint, cone cutter.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Junior Model C434 Air-driven Motor, flexible coupling, expanding brush.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

**ELLIOTT COMPANY - ROTO DIVISION**
*Tube Cleaner Specialists Since 1910*
147 Sussex Avenue, Newark, N. J.

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when control is motivated by outdoor temperatures. Automatic Devices Co., Inc.

**145 Gage Accessories** — Bulletin 600 describes accessories for gages, dial thermometers and recorders. These accessories include attachments for protection of instrument internals against corrosive media and pulsations in pressures; also shows the ring by which turret-case instruments can be panel-mounted. U. S. Gauge Div., American Machine and Metals, Inc.

**146 On Venturi Tubes** — Design features, dimensional data, capacity tables, recovery tables and similar information on Venturi tubes are included in Bulletin 110-N1. Describes standard, fabricated, and non-standard constructions. Also gives information on use of valves in the outlet cone, types of accessories available. Builders-Providence, Inc.

**147 Cooling Tower Control** — Bulletin 1050 discusses a system for automatically controlling make-up water flow, chemical feed, and blowdown rate of cooling towers. Use of this system may conserve water and chemicals, reduce manpower needs and cut maintenance costs. A typical system is diagrammed. Bailey Meter Co.

**148 How Dense the Smoke?** — Bulletin 08113 describes an optical instrument — the M-S-A Smokescope — designed for accurate estimations of smoke density in stack effluent. Advantages of the instrument are fully detailed, as well as operation features. Mine Safety Appliances Co.

### FANS, VENTILATING

**149 Power Roof Ventilator** — Introductory Bulletin 550 describes company's Centrilator, a centrifugal type power roof ventilator. Advantages of operation and design are detailed, and a condensed capacity table is included. Dimensional diagrams and data are also given. Clarage Fan Co.

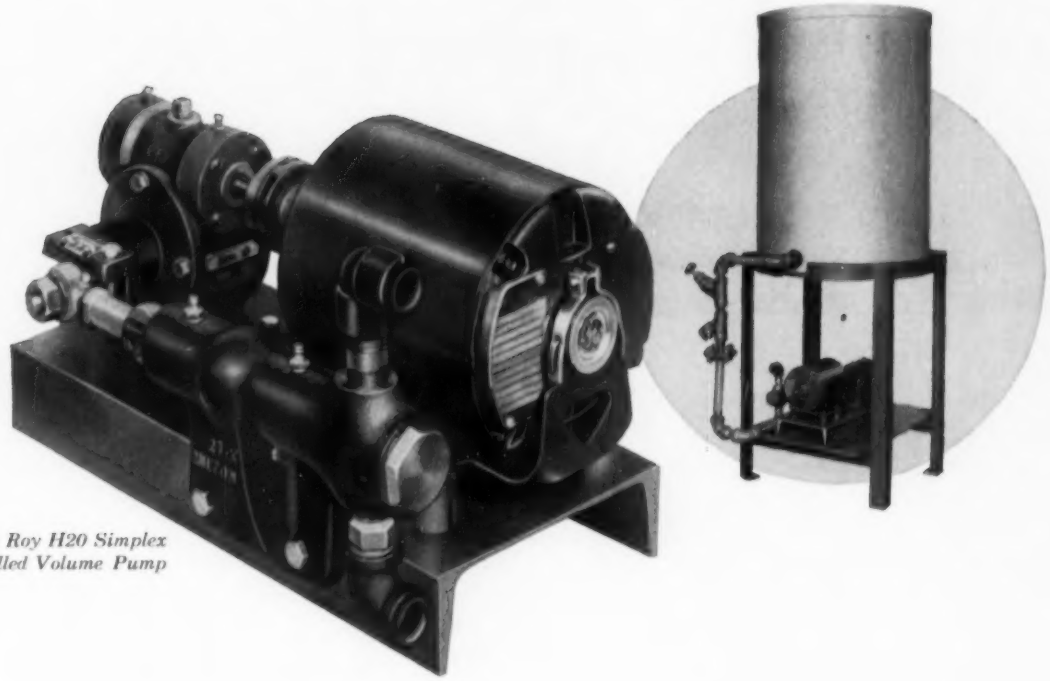
**150 Cooling Tower Fans** — Bulletin A-111B, 8 pp, covers company's line of adjustable-pitch cooling tower and heat exchanger fans. Contains descriptions, specifications and performance data on fans with aluminum-alloy blades in diameters from 40 to 132 in. and models with plastic blades in diameters from 10 to 22 ft. It also includes detailed data on controllable-pitch heat exchanger fans. Hartzell Propeller Fan Co.

### BURNERS, FUEL EQUIPMENT

**152 Fuel System Explained** — Component parts of this company's PT diesel fuel system, how fuel is metered, and other aspects of the system are discussed in 12-pp Bulletin 950138, illustrated in full color. Cutaway views of four fuel pump assemblies and injector make it easy to understand the inner workings of this simple diesel fuel system. A section is also devoted to optional governor arrangements. The PT fuel system is adaptable to engines built by this manufacturer since 1932. Cummins Engine Co., Inc.

**153 Combination Burners** — Bulletin GO-200-B, 6 pp, describes combination gas-oil burners for jobs requiring dual fuels. Together with a supplement describing the oil-firing side of unit, bulletin explains how design improves heating efficiency, lowers fuel costs, and increases operating safety. Also lists input capacities,

*Typical packaged system for boiler-water treating ready for shipment includes an H20 simplex pump, a 50-gallon polyethylene tank, suction piping, close-off and relief valves. Standard tanks are available in steel, stainless steel and polyethylene, to hold 50 or 100 gallons. Write for Bulletin 953.*



*Milton Roy H20 Simplex Controlled Volume Pump*

# Low-cost Controlled Volume Pumps feed chemicals accurately

High metering accuracy, long service life, minimum maintenance and low cost are the big advantages of Milton Roy H20® Controlled Volume Pumps. They embody quality design features usually found only in higher priced pumps, including: self-aligning bearings . . . self-adjusting packing . . . double ball checks on suction and discharge . . . cartridge-type, easily replaceable valves . . . standard continuous flushing connections.

Both simplex and duplex models are available, and conversion from one to the other can easily be made in the field. H20 pumps can be quickly delivered from stock.

You can depend on H20 pumps to meter boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Write for Bulletin 557 and complete specifications.

Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

milton Roy
CHEMICAL FEED SYSTEMS

*Engineering representatives in the United States, Canada, Mexico, Asia, Europe, South America, Africa, Australia.*

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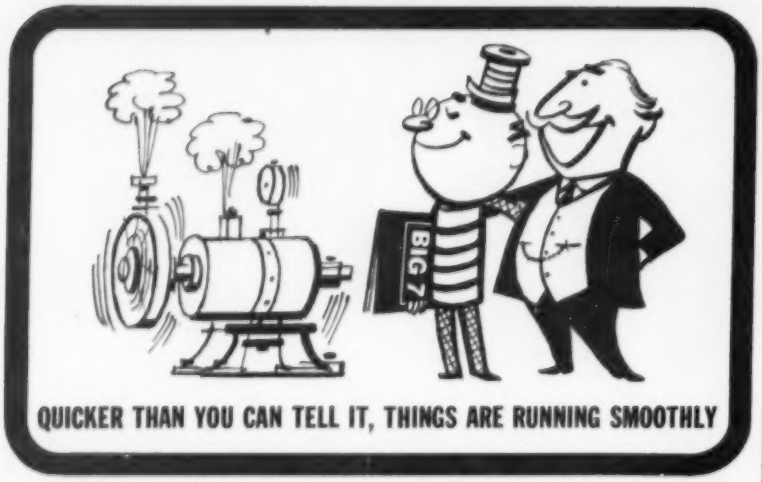


It happens every day. Just when the boss is pushing against time for more production, the No. 1 pump goes bad because of a faulty packing. Downtime begins to add up, and there's the deuce to pay. But with R/M's Big 7 on the job, things can be kept running smoothly. When a new packing is needed, the right one is always at hand, and with so few to choose from the chance of making a mistake is minimized. Fact is, most plants find they can handle all their packing problems with only 3 or 4 of the R/M Big 7.

So why make trouble for yourself? Get hep to the Big 7 line and cut initial investment costs, reduce your inventories, and make ordering mere child's play.

Have a talk with your R/M distributor. He has all the answers and can show you how to take the problems out of packings.

**R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS**

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**BIG 7 PACKINGS**

**RAYBESTOS-MANHATTAN, INC.**

**PACKING DIVISION, PASSAIC, N.J.**

**MECHANICAL PACKINGS AND GASKET MATERIALS**

**FACTORIES:** Passaic, N.J.; Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

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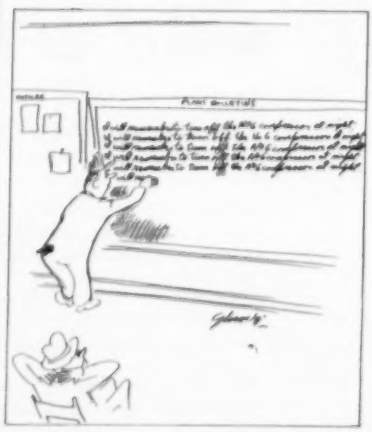
output ratings, and construction details required for installation. The Mettler Co., Inc., Div. of Eclipse Fuel Engineering Co.

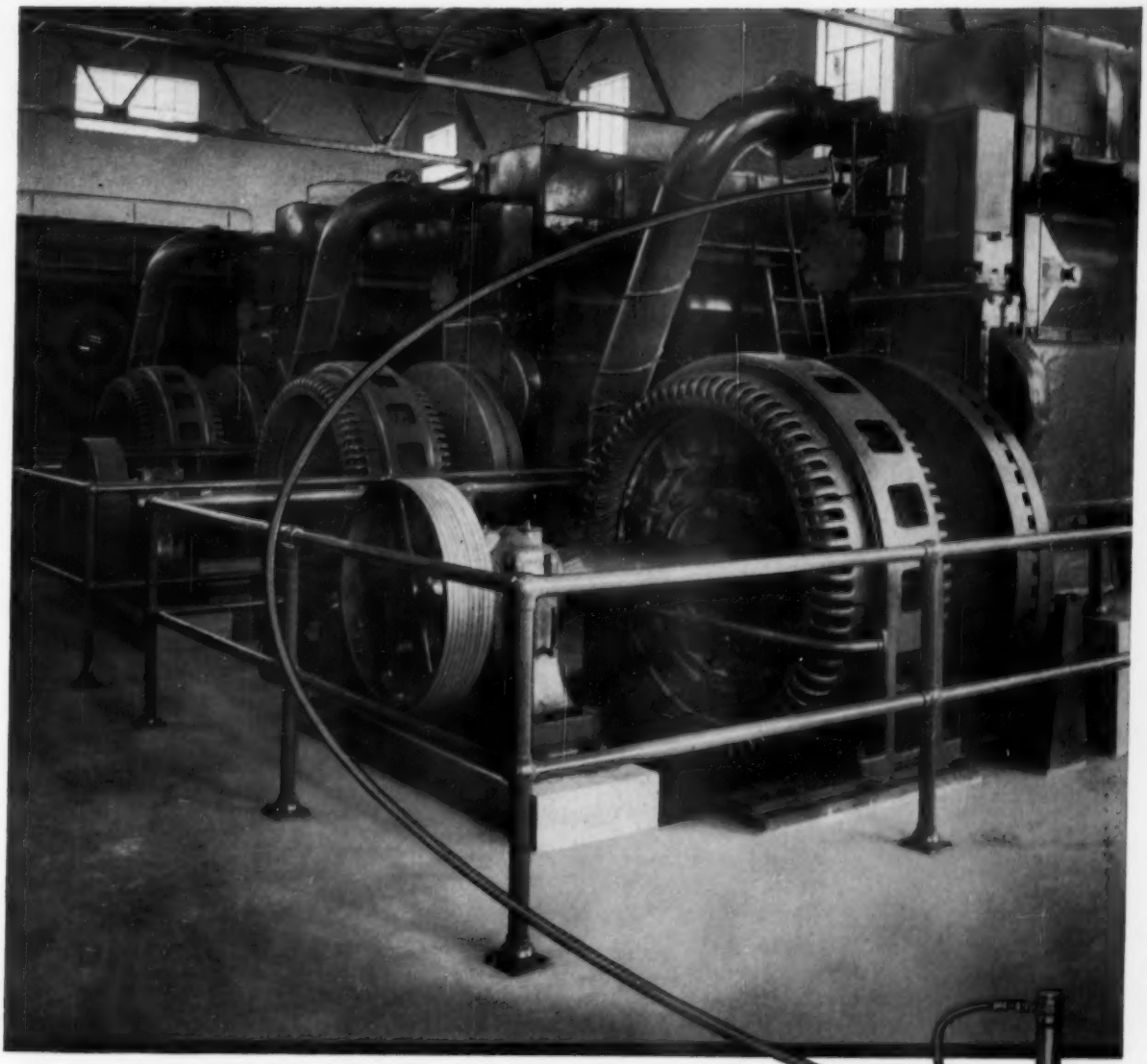
### OTHER EQUIPMENT

**154 Insulating Oil Purifiers** — Bulletin 10-107 describes company's centrifugal insulating oil purifiers designed to keep insulating oil free of water and sediment. Tells how these purifiers work and gives complete dimensions, capacities and specifications on the various types and models. Also shown are photos of actual installations. The De Laval Separator Co.

### . . . Recent Publications of Special Interest

**156 Hiring Scientifically?** — Tests and other materials for use in personnel selection and training are described in the 1957 edition of this organization's industrial catalog. Although aimed at personnel men, the catalog should aid power engineers concerned with selection of their own staff employees. It suggests materials to be used in selecting employees, improving their performance and reducing turnover. Tests described cover intelligence, interest, personality, aptitude and skill measurement. Also describes use of a morale survey available. Science Research Associates.

**157 Rotary Seal Data** — Power engineers concerned with process equipment will find it easy to select the right type of mechanical seal for a specific operating condition with Form 480, a 16-pp catalog on rotary mechanical seals. It is extensively illustrated with cutaway views showing stuffing box installation details. Each seal is attended by a quick reference covering temperatures, pressures and fluids it is designed to serve. Durametallic Corp.

**158 Retractable Soot Blowers** — Six-pp Bulletin 1030 describes retractable soot blowers available in lengths to 38 ft. Cross section drawings explain workings of all moving parts and actuating components. Also listed are special design features incorporated for effective tube cleaning. Copes-Vulcan Div. Blaw-Knox Co.



# NO STUCK RINGS!

Stop the formation of varnish, sludge and carbon in your Diesels and *keep it stopped* with Sinclair RUBILENE®, the high viscosity index oils proved by over 35 years in industrial Diesel applications. RUBILENE earns its reputation by its performance under continuous operation and heavier loads. It fights deposits and gives better protection to cylinders, pistons, rings and other vital moving parts. Your Diesel stays on the job longer . . . service time is cut 'way 'way down!

Let RUBILENE help solve your lubrication problems. Regardless of the make or age of your Diesel, where a high VI oil is needed, there's a member of Sinclair's RUBILENE or RUBILENE HD family that meets your requirements exactly. Call your local Sinclair Representative for further information or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Ave., New York 20, N. Y. *There's no obligation.*

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# Combine them

## *any way you choose for your boiler blow-off*

Quick-opening

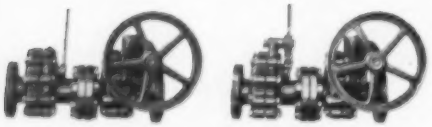
Slow-opening Angle Type

Slow-opening Y Type

Straightway and Angle Duplex Units

Straightway and Y Duplex Units

Angle and Y Duplex Units



Straightway Duplex Units

More than a dozen different arrangements of valve designs and operating methods are available to you in the complete Everlasting line of boiler blow-off valves for operating pressures up to 600 psi. Here is a range of selection from which you can get exactly the combination you wish.

For half a century, Everlasting Valve designs have been proving their effectiveness, reliability and durability—the kind of service you need for boiler blow-off. Each design fully meets ASME Code requirements. **WRITE FOR BULLETIN**

*For "everlasting" service, use*

EVERLASTING *Valves*

**EVERLASTING VALVE CO.**
**47 FISK STREET, JERSEY CITY 5, N. J.**

EV504

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**159 Work Clothing** — Catalog 101, 16-pp, is filled with illustrations and descriptions of uniforms and work clothing of every type. It contains a special section describing various clothing and uniforms designed especially for power plants and others. M. Setlow & Son, Inc.

**160 Bridge Cranes** — Bulletin DH-459A describes the B-47 hand traveling crane available in capacities of 3 to 10 tons with spans up to 50 ft. Contains data on construction details, weights, dimensions and other general information of interest to power engineers. Wright Hoist Div., American Chain & Cable Co., Inc.

**161 High Temperature Alloys** — Engineering properties and fabrication of ten high-strength alloys for elevated temperature service are described in detail in this 20-pp bulletin. Technical information includes physical constants, mechanical properties at room and elevated temperatures, heat treatment, forging, cold working, welding and corrosion resistance. Recommended uses are spelled out for each alloy with a discussion of how to use stress-rupture and creep data in designing components for high temperature service. The Carpenter Steel Co.

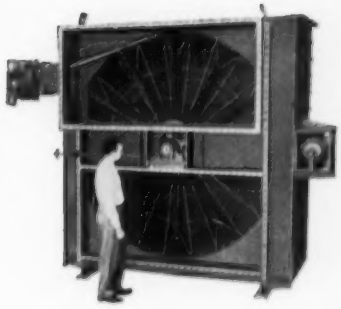
**162 Condenser Tube Protection** — How stainless steel clip-on tube protectors safeguard condenser tubes from impact of fast flying water droplets is told in Bulletin 19B8590. Cites examples of how these protectors have eliminated erosion effect on the tubes. Shows a typical erosion pattern on the steam side of a condenser and design details of the protector. Allis-Chalmers Mfg. Co.

**163 Condensing Units** — Data Sheet 493, 8 pp, includes specifications and capacities for open type refrigeration and air conditioning condensing units from ½ through 100 hp. In addition, specifications are included for compressor units for use with evaporative condensers, ½–100 hp. Simple compressors in single and two-stage for use with horsepower up to 100 are also included. Data and specifications are given for condensing units with Freon-12 or Freon-22 refrigerants. Brunner Mfg. Co.

**164 Rubber Dock Bumpers** — This catalog sheet illustrates and describes company's line of Flex-O Rubber dock bumpers, designed to protect docks and trucks, reduce damage to fragile freight, and eliminate dock maintenance and prevent dock downtime, by absorbing impact of trucks backing into docks. Detailed specifications and descriptive data are included. Bumpers, Inc.

**165 Conversion Factors** — This reference table features common conversions such as inches to centimeters or watts to horsepower, as well as many conversions difficult to locate in reference manuals, as, for example, atmospheres to Kgs per sq cm, cm per sec to miles per hr, cu ft to liters, microns to meters. Precision Equipment Co.

**166 Solids-Contact Reactors** — Bulletin 5001, 24 pp, features a cut-away photo showing internal construction of company's solids-contact reactor, and includes plan and elevation drawings covering variety of designs available. Discusses theory and problems of cold water clarification, as well as advantages and applications of different designs. Also provides section on auxiliary and supplemental apparatus available. Cochrane Corp.



# HOW MANY STACK BTUs DO YOU BUY EACH YEAR?

Whether you burn it — or dissipate it up the stack — every BTU costs you money. In fact:

***Yearly cost of fuel often equals the cost of your boiler.*** That's why heat recovery — or dollar recovery — is so important. Boilers simply have huge appetites for fuel . . . fuel that's constantly going up and up in cost.

***And small boilers are no exception.*** Even with relatively small boilers — that is, between 25,000 and 250,000 lbs per hr — substantial heat recovery is possible. With a Package Ljungstrom Air Preheater, fuel consumption is most often reduced 10% or more! As a result, many plants have written off their Ljungstrom within two years.

***Get more steam, and cleaner stack gases.*** Put it another way. The BTUs that you save with a Package Ljungstrom can be used to increase boiler output. What's more, higher combustion temperatures cut slagging . . . keep stack gases clean . . . allow use of cheaper fuels . . . reduce corrosion.

***Comes complete, ready to install.*** Determine for yourself how easily a low-cost, *shop-assembled* Package Ljungstrom can be applied to your generating or process system. Ask for our brand-new 16-page brochure. It's yours with our compliments, simply by writing to the address below.

**The Air Preheater Corporation** 60 East 42nd Street, New York 17, N. Y.

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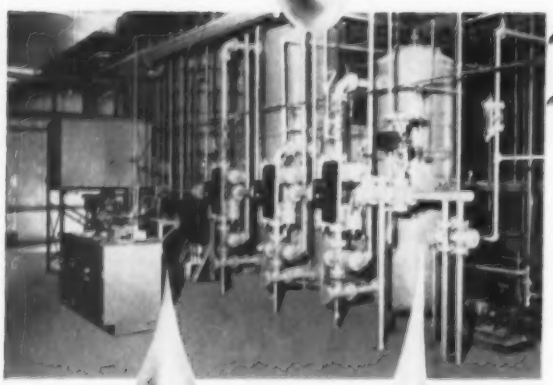
# DEMINERALIZATION EQUIPMENT

*.....engineered to meet your requirements*



**MAXIMUM RELIABILITY**

**HIGHEST QUALITY WATER**

Check some of these installations. They are representative of INFILCO's advanced engineering and development in providing water suitable for modern industrial process and power requirements.

**Crystal Ice and Cold Storage Company** . . . Phoenix, Ariz.
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**Hytron Radio & Electronics Company** . . . Kalamazoo, Mich.
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**Turnsted Division, General Motors Corp.** . . . . Columbus, Ohio
**Security Engineering Div. Dresser Industries** . . . Dallas, Texas

It will pay you to investigate. Write today for Bulletin 1960-C. Inquiries are invited on all water and waste treatment problems, including boiler feed water makeup, process water clarification and purification, waste pollution control, material reclamation and related needs.

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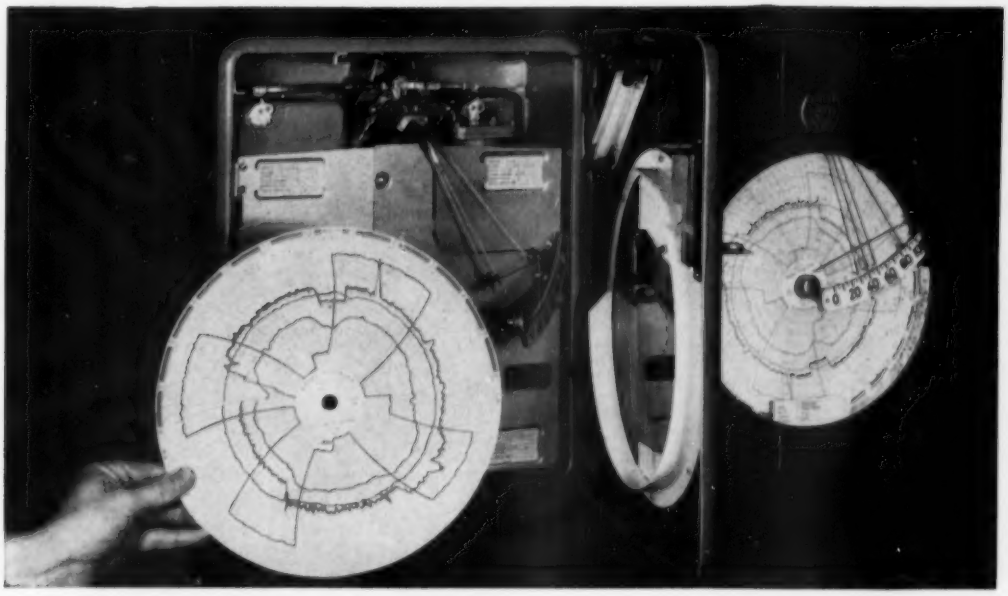

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## Clear, Continuous Records without Poisoning . . . on the New Bailey Recorder

★ Faithful chart records of measured variables are the key to a meaningful, dependable analysis of operating trends and conditions. Money spent for more accurate metering, for faster response, is money down the drain—*unless* it's matched with chart records that are equally accurate.

That's why these features of the new Bailey Recorder are important to you:

1. Bailey's exclusive sealed capillary-action inking system maintains continuous flow to the pen tip, and traces sharp, opaque, quick-drying records. "Poisoning" of intersecting records is practically eliminated; no blots or smears during operation or chart changing.

2. Pens are mounted on concentric centers, trace on parallel time arcs only 42/1000" apart. This simplifies analysis of two or more records.

3. Interchangeable plug-in receiver units permit practically limitless record-grouping combinations.

Write for Product Specification E12-5 and actual chart sample.

**ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER**

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
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*Controls for Power and Process*

BAILEY METERS
*Controls for*
TEMPERATURE
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# CONSTRUCTION NEWS

**Chula Vista, Calif.** — San Diego Gas & Electric Co, 861 Sixth Ave, San Diego, Calif., has authorized an expansion program at company's South Bay power plant, near this city. Work will include the installation of a 135,000-kw turbine generating unit, high pressure boilers, and auxiliary equipment. When the South Bay unit, which will be 25% greater in capacity than any unit now in operation in the company system, is placed in line, total generating output of entire system will be boosted to more than 807,000 kilowatts. Construction of the new unit is scheduled for the latter part of this year and is scheduled for completion in early 1960.

**Pittsburg, Calif.** — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif., has authorized plans for the expenditure of $83,200,000 to double the size of its Pittsburg, Calif., power plant, completed in 1954 as the largest generating plant in the West. Company plans to install two new generating units, each with an initial capacity of 325,000-kw to present installations with an existing generating capacity of 600,000-kw. Application to get the work under way has already been filed with the California Public Utilities Commission. The first unit is scheduled to go in service in 1960 and the second in 1961, to meet load growth and maintain a reasonable reserve capacity.

**Hartford, Conn.** — Connecticut Light & Power Co, 36 Pearl St, has arranged a construction program to cost about $35,000,000 during 1957 for expansion and improvements in plants and system. Work will include extensions in generating capacity, transmission lines, distribution system, etc. Company is in the process of arranging financing in the amount of $15,305,367 to cover part of the proposed construction costs.

**Kansas City, Kan.** — Kansas City Power & Light Co, 1330 Baltimore St, has announced that it has contracted to sell its electric and gas utility systems in Iowa to Interstate Power Co, 1000 Main St, Dubuque, Iowa, for an amount approximating $17,000,000, subject to approval of the regulatory bodies. The Iowa operation is about 300 miles from Kansas City and there is no direct physical connection between the two systems. The company's transmission lines from Kansas City to Des Moines and Davenport, Iowa were not included in the transaction. Proceeds of the sale will be directed to capital requirements necessary in construction program in Missouri-Kansas service area.

**Baton Rouge, La.** — Gulf States Utilities Co, (Louisiana Division) 340 Florida St, has approved a construction budget of $48,000,000 for improvements and expansions in company's systems and plants for 1957. Proposed plans include the installation of a new steam-electric generating unit here, with an initial capacity of 162,000-kw. Cost of this installation is reported in excess of $20,000,000. This year's expenditures are part of a $150,000,000, four-year construction program, to insure ample electric light and power to meet the ever increasing demand of company's 28,000 square mile service area. More than $21,000,000 alone will be spent on transmission and distribution lines.

**Baltimore, Md.** — Baltimore Gas & Electric Co, has announced a 1957 budget for expansion of company's facilities to approximate $40,000,000. Company is planning financing in the amount of $32,000,000 early this year in the form of a bond issue and the remainder of $8,000,000 will come from internal company sources, for its construction program. Most of this year's budget will be expended in the direction of new and improved electric and gas transmission and distribution lines, although some several millions of dollars have been earmarked for completion of the 125,000-kw generating facility under the process of installation at company's Herbert A. Wagner power plant scheduled for completion in early 1959.

**Duluth, Minn.** — Minnesota Power & Light Co, 30 West Superior St, has filed a registration statement with the Securities and Exchange Commission for permission to finance a fund of $12,000,000 through a bond issue. Utility plans to use part of the money to pay back some short term bank loans in the amount of $3,350,000 and the balance for the balance of this year's expansion and improvement program, covering expansion and improvements in power plants and system, transmission lines, and operating facilities.

**Minneapolis, Minn.** — Ten utility companies have announced joint plans for the construction of a 60,000-kw nuclear power plant to be located on a site now being selected in the four state territory served by the Northern States Power Co, of this city. New plant will be a controlled re-circulation boiling water reactor and is scheduled for completion in early 1962. Research and development work will be financed by member utilities that are forming a corporation for the purpose. Northern States Power Co, will eventually own and operate the plant and furnish power and electricity to members of the group through its own power network. Pioneer Service & Engineering Co, Chicago, Ill., architect-engineers.

**St. Louis, Mo.** — Union Electric Co of Missouri, 315 N 12 Blvd, has preliminary plans under way for construction within the next five years two new generating plants with a combined capacity of 700,000-kw. New units, included in a $330,000,000 expansion program for the five-year period will increase total capacity of company's system by one third, at a cost in excess of $117,000,000. A $67,000,000 plant, first of the two units planned will be started on completion of a 280,000-kw installation now under construction and scheduled for completion by June of 1958.

**Newark, N. J.** — Public Service Electric & Gas Co, 80 Park Pl, has announced filing of an application with the Securities and Exchange Commission, for permission to arrange for a bond issue of $50,000,000, to cover costs of present construction program. Utility also announced that it has acquired a 120-acre building site on Duck Island, Hamilton Township, N. J., for the construction of a new steam-electric generating plant. The site, just outside of Trenton, extends from the Delaware River to the Trenton-Bordentown branch of the Pennsylvania R.R. Project will include initially a 300,000-kw turbine generator with boiler and auxiliary equipment, along with transformers and transmission lines to interconnect with company system. Completed project will cost an estimated $72,500,000.

**New York, N. Y.** — Consolidated Edison Co of New York, Inc, 4 Irving Pl, will expend $650,000,000 over the next five-year period, for expansion and improvement in generating facilities, transmission lines, power substations and miscellaneous work. A budget of $146,000,000 was set for 1957 to include $77,000,000 for electric transmission and distribution lines, $57,000,000 for electric generating facilities and auxiliary equipment, $2,000,000 for the steam department, and $3,000,000 for miscellaneous corporate purposes.

**Poughkeepsie, N. Y.** — Central Hudson Gas & Electric Corp, South Road, has announced plans for the expenditure of $50,000,000 during the next three years, to meet the increasing demands for electricity and gas. A considerable part of the appropriation will be used in connection with expansion of steam-electric generating plant at company's Danskammer Point Steam Station which will cost an estimated $23,400,000. New unit with an initial capacity of 138,000-kw will boost utility's total generating capacity to 344,200-kw when placed in line in the fall of 1959. Company plans improvements and additions to transmission lines, power substations and other operating facilities.

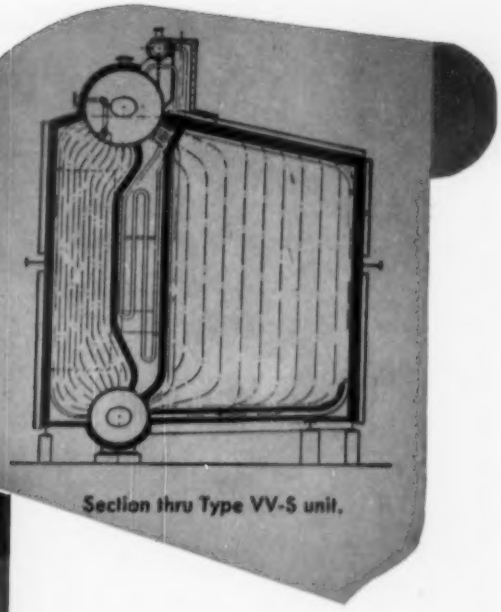
**Dayton, Ohio** — Dayton Power & Light Co, 25 N Main St, has announced a construction program for 1957 to exceed an expenditure of more than $37,000,000. Utility is arranging for the sale of stock offering in the amount of $13,802,460, proceeds of which will be used in expansion of generating facilities, transmission lines, power substations and other corporate work.

**Portsmouth, Ohio** — The Atomic Energy Commission has announced an extension of the Goodyear Atomic Corporation's contract to operate AEC's gaseous diffusion plant located here, for a period of four years, with an expiration date scheduled for June 30, 1961. Company, a subsidiary of the Goodyear Tire & Rubber Co, Akron, Ohio, operates one of the commission's three installations for the refining of fissionable uranium-235, by the gaseous diffusion process. Initial work on the plant began in 1952 and upon completion, will represent an investment in excess of $745,000,000. Company has now under construction a new plant for the preparation of uranium hexafluoride feed for the main plant from uranium oxide.

**Washington, D. C.** — Potomac Electric Power Co, 929 E St, NW, will expend approximately $34,000,000 for expansion in generating facilities, transmission lines, power substations and miscellaneous work. Program includes $7,740,000 for new generating capacity, $5,537,000 for transmission lines, $21,036,000 for distribution and substation equipment and about $687,000 for other plant expansion. Company is now planning financing in the amount of $45,000,000 to cover these costs and to repay bank loans incurred in construction program. Company plans to spend an additional $32,000,000 on expansion in 1958

# More Steam with Fewer Dollars

# Vogt TYPE VV-S STEAM GENERATORS



Section thru Type VV-S unit.

Two 30,000 #/hr. units under erection at an Air Force Base.

A 65,000 #/hr. unit in a Texas Petroleum Refinery

- ★ Headerless construction for full unrestricted water circulation.
- ★ Large water storage capacity and correspondingly greater steam relieving space.
- ★ Long, narrow furnace ideal for oil or gas fuel.
- ★ Completely steel encased for "out-in-the-open" operation.
- ★ Simple slab foundation.
- ★ Capacities from 50,000 pounds to 100,000 pounds steam per hour.

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# EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 113–114 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

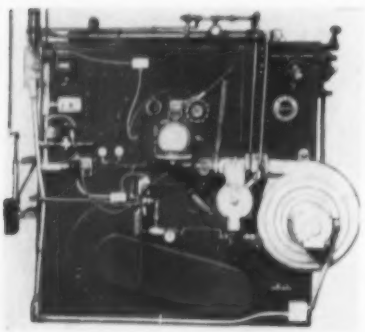
### 1—LOADING STATIONS for pneumatic control system use

These auto-manual control loading stations are non-seal type, said to assure "bumpless" transfer from automatic to manual positions or vice versa without process disturbance or upset. According to manufacturer, transfer is a matter of matching gage pointers and turning an adjustment knob. The design permits omitting one control station normally used in many cascade control circuits. Pressure range is 3 to 15 psig, with pressure gages scaled from zero to 100 per cent.

Both standard and miniature devices are available. The latter stations have the added characteristic of grouping into a more compact area where space is limited. Stations are available for functions such as loading and transfer, selector biasing, ratio, remote set-auto manual, cascade-auto manual, cascade-biasing, cascade-ratio, manual loading and bias-loading. Besides process control systems, the stations are reported suitable for use as components in combustion, feedwater regulation, pressure reduction and desuperheating and control system installations. Copes-Vulcan Div., Blaw-Knox Co.

### 2—PACKAGE BURNERS help cut fuel and maintenance costs

Calorex Planned-Package Burners come in standard models to meet varying requirements for power generation, heat, steam generation, and hot water. They are reported to offer top burner efficiency and automatic firing with any



grade of fuel oil, and changeover in minutes to gas when it is more economical. Combustion performance of 12½ per cent $CO_2$ without smoke is claimed along with worthwhile savings in fuel costs. The automatic firing feature gives boiler room automation, says manufacturer, and results in labor saving costs in many installations. The bolt-on units are announced as combining the efficiency, throttling range and dependability of company's rotary cup air atomizing combination forced draft with the dual fuel flexibility of their cartridge gas burner and controls. W. N. Best Combustion Equipment Co., Inc.

### 3—SUPERVISORY CONTROL for demineralizing equipment

The Robotel Controller is announced as a signalling system which provides an alarm and record of the malfunctioning of any component in demineralizing equipment intended to operate in accordance with a predetermined program. It is also designed to provide for automatic shutdown of the programmed operation, if desired. This controller assumes that sooner or later a failure of a component will occur in any automatic control system. Depending on the nature and complexity of the system, such failure may be difficult to locate and correct promptly. It is explained that by means of the Robotel, the location of the function failure is immediately indicated, alarmed and recorded — thus enabling prompt correction. Its application to an automatic multi-unit demineralizing plant is discussed in detail in company's Reprint 66. Infilco Inc.

### 4—POWER ROOF VENTILATOR is centrifugal type unit

Distinguished by a jet siphon feature, the Centrilator is a centrifugal type power roof ventilator. Stability, high efficiency and quiet operation are attributed to such design features as the jet siphon, and streamlined air flow. Also, the Centrilator is designed to give high static pressures (up to 2 in.). It is thus suited for applications where ductwork or hoods may impose considerable resistance, as well as for light-duty applications without ductwork.

Four lifting lugs facilitate handling and a pipe is provided for the wiring. Four bolts secure the unit to the roof. Requiring only a low curb, the Centrilator has a low overall height when installed. It is built in 10 standard sizes with capacities to 26,400. Bulletin 550 gives details. Clarage Fan Co.

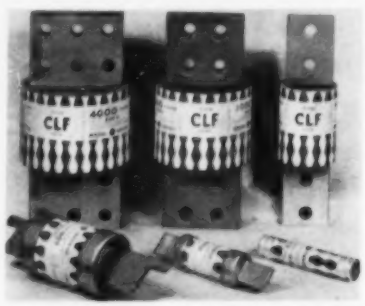
### 5—CONTROL DEVICE guards against overheating

For fast-acting precision control of critical temperatures necessary to many processing operations, the Model HL 15-10 acts to cut off the heat supply if a predetermined temperature, set on the calibrated scale, is exceeded. Bulb temperature is indicated on the scale at all times. Snap acting switch in the control circuit is the manual reset type. It is explained that once the temperature has risen to the predetermined set point, and the switch has broken the control circuit, the circuit cannot be re-established until the manual reset button has been pressed.

A second switch has been provided in series with the control switch. This second switch is normally closed and designed to open only if the temperature should drop to a point below lowest expected ambient temperature. This is provided as a fail-safe feature, as any loss of fill in the thermal element will cause a drop in indicated temperature. Scale and element ranges are 0 to 900 and 0 to 1100 F. Bulletin 311 gives specifications. The Partlow Corp.

### 6—CURRENT LIMITING FUSES offer high interrupting capacity

This line of current limiting fuses is announced as having a tested interrupting capacity of 200,000 amp symmetrical. Designed to interrupt short-circuit currents in less than ¼ cycle, the Type CLF Fuses are for protection of branch feeders, lighting circuits, motor starters,



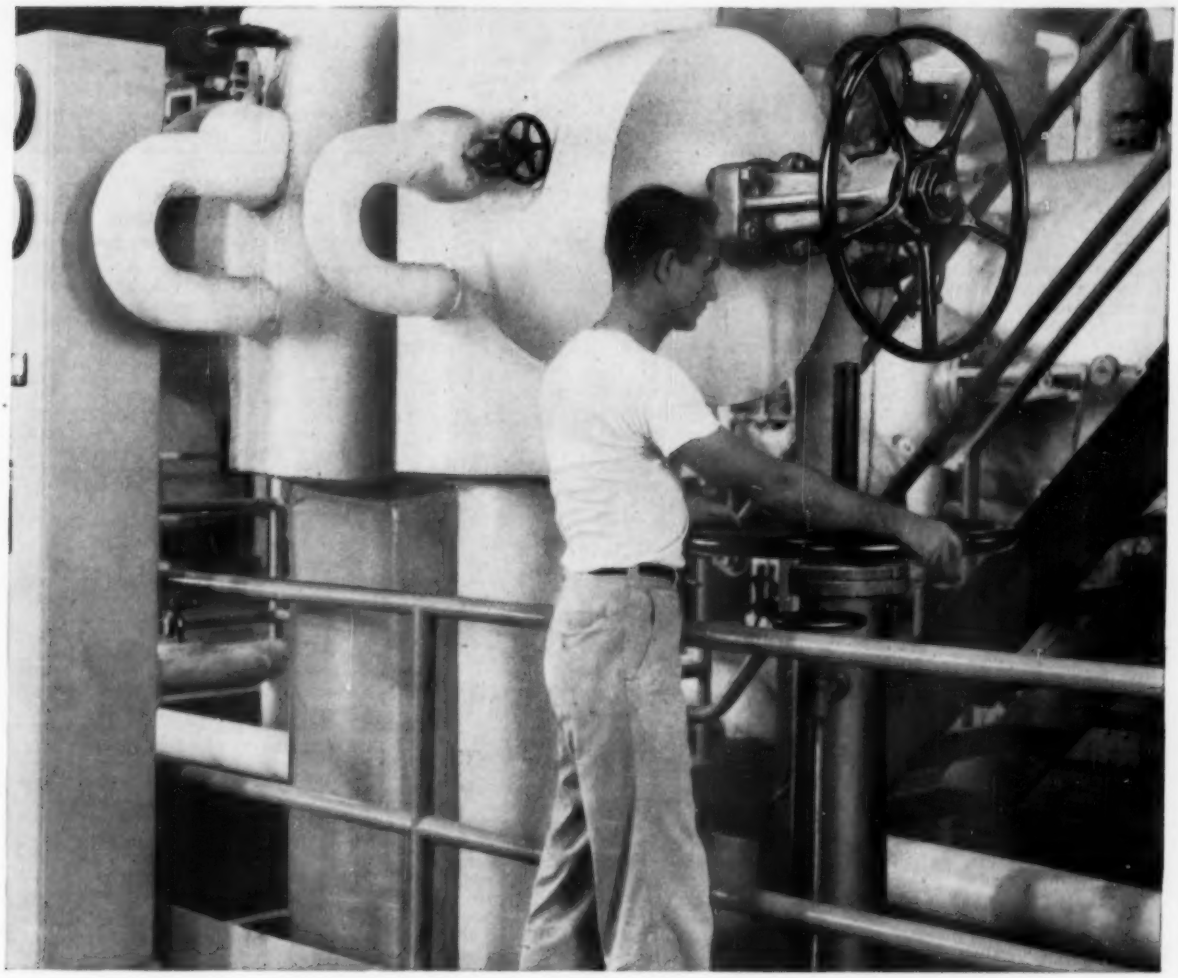

control power circuits and similar applications where most fuses do not have sufficient capacity. They come in ratings from 6 to 4000 amp.

The CLF Fuse is announced as a one-time, low voltage, cartridge-type unit with external mounting dimensions meeting pertinent NEMA Code requirements and UL standards. The fuse body is an insulating tube reported to offer strength and resiliency. Silvered copper ferrules or knife blades at each end fit any standard NEC fuse holder of corresponding voltage and current rating, 600 amp and below. Above 600 amp, tangs are provided for bolt mounting. A fusible silver element is embedded in inert granular quartz filler and connected from ferrule to ferrule. It is explained that when the fuse functions, the arc that occurs is cooled by the quartz and extinguished without expulsion of gases or materials from the tube. General Electric Co.

### 7—V-S DRIVE holds speed despite changes in load

Claimed capable of maintaining any speed in its range within ¼ of 1 per cent accuracy, regardless of load fluctuations, this drive is a packaged system consisting of company's Varidrive Variable Speed Motor or Varidrive Aero Test Stand and the new Speed Sensitive Varitrol, an automatic control package. The Varitrol operates on a tight loop, high response, feedback principle. This pneumatic control offers advantages of low initial cost, simplicity of construction and operation, minimum of mainten-

How Crane Steel Valves Cut Power Piping Costs



# Everything's O.K. below—since 1942

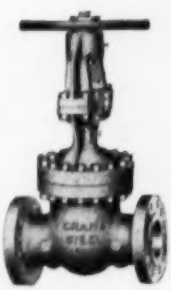
Always smooth, always positive in action—says the operator of this Crane 10-inch, 600-pound steel gate valve with extension yoke . . . and never a sign of leakage at the seats or bonnet joint.

That's the way this valve has performed for 15 years—since it was installed in a main steam cross-over line in the Nueces Bay Station of Central Power & Light in Corpus Christi. It's on working pressure of 400 psi at 830 deg. F.

The cost-in-service record of the valve is clean. It has not been touched by a mechanic except for ordinary routine servicing. Indications are it will remain in the line for a long time to come.

Unusual performance? Not for Crane steel valves. They're famous for cutting power piping costs. They're better suited for such service because of quality castings made in Crane's own foundry—with closely controlled heat-treating techniques . . . exacting machining, assembling and testing procedures that are unique with Crane.

You can be sure of low-cost steel valve performance when you specify Crane. Get all the facts from your Crane Representative or write to the address below.



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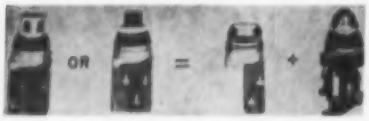
ance, and inherent explosion-proof characteristics. It is pointed out that although designed primarily for company's test stand motors used for testing aircraft components, this speed sensitive control can be adapted to any Varidrive for industrial applications in which exact speed regulation is a requirement. U. S. Electrical Motors, Inc.

### 8—MULTI-USE LUBE is molybdenum-based product

Gear-Moly is announced as the aspirin of the lubrication field because it solves many industrial lubrication headaches. A little bit goes a long way to reduce bearing wear and failure and in lengthening gear tooth life, according to manufacturer. Gear-Moly is reported of great value, also, on sliding surfaces and worm drives, in keeping rubbing areas friction free and gear cases cool. Gear-Moly contains microscopically ground molybdenum disulfide suspended in SAE 90 gear oil. A small quantity added to heavy oils and greases works wonders, it is claimed, only 2 oz per pound of oil or grease being required. An 8-oz can costs around $2.00. Pacific Lubricants Co.

### 9—PUSHBUTTON incorporates an indicating light

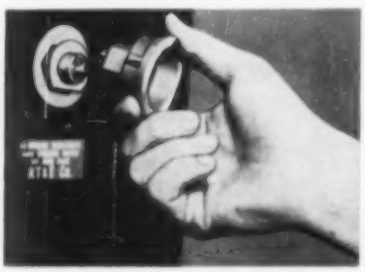
An illuminated oiltight pushbutton, the CR294OUW, combines in one unit the functions of both pushbutton and indicating light. It is reported to save about 50 per cent in panel space. Readily fitted in the same hole and mounting space as existing oiltight units, the device can be




panel-mounted or back-mounted, according to company. It has transformers rated for 110-, 220-, or 440-v, 60 cycles. The pushbutton unit's transformer provides safety of a completely insulated secondary winding, it is noted, and is potted in permafil compound for strength and resistance to mechanical damage. The strongbox transformer is the same size as the heavy-duty oiltight contact block, which is the same as used in conventional units. The pushbutton unit may be had in guarded or unguarded form; it uses company's No. 12 6-v bulb. Color caps are available in six colors. General Electric Co.

### 10—TRANSFORMERS, dual voltage, offer faster changeover

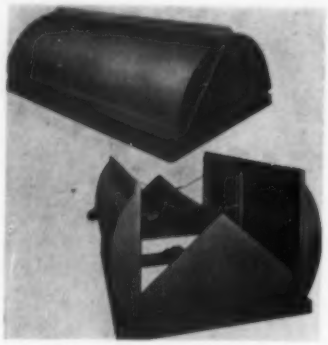
These dual voltage distribution transformers utilize an externally operated voltage changeover switch designed to reduce labor time, down time, and transformer costs when an increase in system voltage is contemplated. Changing the transformer for operation on a higher voltage is accomplished by a 90-deg rotation of the externally operated voltage changeover switch. The transformer is insulated for the highest nameplate voltage, it is noted; losses and performance are comparable to conventional single voltage transformers. Company says these dual voltage models are competitively priced and available in sizes from 10 through 167 kva with primary



voltage combinations of 2400/4800 v, 2400/7200 v, 4800/14000 v, and 7200/14000 v and with standard secondary voltages. RT & E Corp.

### 11—FIRE RELIEF VENT operates above the roof line

The Pyrojector, a quick-opening "fire vent" to permit rapid escape of smoke, heat and gases in event of fire, installs and operates entirely above roof line.



Two double-wall dampers are opened outward by coil springs when a fusible link melts at 212 F. This creates a roof opening of 28 sq ft. This relief near the fire source helps limit horizontal spread of flames, company points out, and aids fire fighting by revealing the location of the flames. The Pyrojector is weatherproof when closed, it is noted, and can be used for extra ventilation in good weather. It can be installed single or in groups above likely fire sources. Form 701 gives details. The Swartwout Co.

### 12—MIDGET LIFTERS are strong, easily handled

The Type C Pull-A-Way is announced as a strong, tough, versatile and easily-handled unit for all raising, lowering and pulling jobs. The lightweight device has a frame of forged aluminum alloy. It is suggested for moving motors and other machinery, stretching and holding tension supports, setting pipe in trenches, skidding loads, holding cement forms and other "quick hook-up jobs." Manufacturer says its engineering features are similar to those of its larger counterparts — it has a double interlock to keep the brake from slipping, an automatic notch-per cycle letdown, and a safety handle to prevent serious overloading. It is available in 1½-, 3- and 6-ton capacities. Standard lift of all units is 5 ft. For the smallest size, the full load pull on the handle is 83 lb., length of chain is 5½ ft, and weight is 23½ lb. Wright Hoist Div., American Chain & Cable Co., Inc.

Reader Service Cards on pages 113–114 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

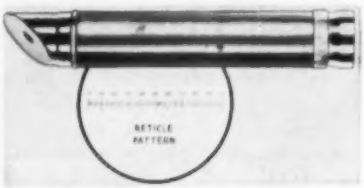
### 13—AIR CONDITIONERS offer style, safety features

Advanced styling and numerous safety devices are announced for this company's 1957 line of package air conditioners, available in six ratings from 3 to 20 tons. Heavy-gage furniture steel is used for cabinet construction; it is coated with a rust-resistant primer and finished with gray metallescent enamel. Inside the unit is a new sloped cooling coil design, said to permit greater cooling area for a given coil size. Performance characteristics of the sloped coil design are augmented by use of spiral aluminum and staggered copper tubes. According to company, the greater air-coil contact achieves results in better heat and moisture transfer; also the new units feature a more efficient draw-through air flow design which contributes to increased cooling capacity.

To provide protection for operating components, overload cut-outs are part of the compressor motor and fan motor circuitry. The compressor has a thermal cut-out which acts to cut off motor should temperature exceed a predetermined limit. The condenser has a fusible plug which melts to release refrigerant from the system in the event of excessive pressure build-up. Pressure controls are incorporated in the units. American Blower Corp.

### 14—MEASURING MICROSCOPE is no bigger than fountain-pen

No larger than an ordinary fountain pen, this handy pocket instrument is described as ideal for making direct reading measurements and for checking




small parts and dimensions under powerful magnification. Instrument contains a precision, glass etched reticle calibrated for measurements up to ½ in. by 0.001 in. divisions. Estimates to 0.0005 in. can be made, company says. Chrome reflector at base of instrument reflects light on object examined or measured. The instrument is priced at about $8. Edmund Scientific Co.

### 15—VALVE ACTUATORS can work in difficult conditions

All-metal actuators for control valves are announced for use under conditions of atomic radiation, high temperatures and corrosion. Designed for both pneumatic and hydraulic control systems, these actuators are available with suit-

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able valves as complete control units, or as additions to existing valve installations. Some are designed to function either "air to open" or "air to close" and are reversible in the field.

For use in highly corrosive atmospheres, one model has stainless bellows and stem. Its frame is made from cadmium plated, cold rolled steel. It comes in three ranges of signal pressures from 3 to 15 psi to 9 to 45 psi. Possessing a maximum thrust of about 3000 lb, the actuator is compact in size. One unit, available "air to close" only, is made completely of stainless steel. This line of actuators also includes smaller models. Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

### 16—AIR FILTERS for pneumatic control systems

These instrument air filters are designed to remove fine dirt particles and entrained liquid droplets from compressed air streams. They are available in two types. Where processes or instruments require small quantities of clean compressed air, filters with special felt type filter media are used. Efficiencies of over 95 per cent on particle sizes down to 1 micron are reported. When air temperature at filter is over 200 F, metal media type filters are used. Built of metal disc type design, these operate under higher temperatures with no change in performance. Metal disc construction also extends filter area, it is noted, providing initially low pressure drop and long service period before pressure drop builds up. Bulletin IAF-856 gives full details. Air-Maze Corp.

### 17—FLEXIBLE SHAFT TERMINALS for remote control of valves

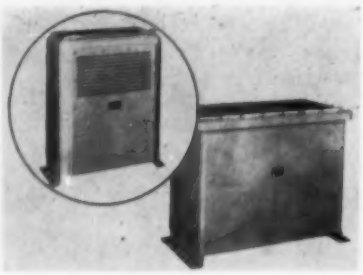
By using these standard terminals it is unnecessary to rely on do-it-yourself arrangements, manufacturer points out, and valves can be controlled at any point from a remote location. Now available are valve couplings, intermediate connections to go through floors, and remote operating stations. Shown at left is a remote operating station, Model RIH. It is simply bolted in place and the flexible shaft pinned to the spindle. The indicator shows when the valve is open or closed. This remote station is available also with a collar in place of the flange, in order to weld it in place.

Valve couplings shown are designed to fasten to valve handwheel spokes by U-bolts. (Drilling of flanges is done at

this time.) Three types of couplings shown (left to right) are Type V3 for rising handwheel valves (this has a square sliding joint), Type V2 for rising stem gate valves, and Type VI for non-rising handwheel valves. Valve couplings can be had with or without quick disconnect attachment shown on Type VI. After couplings are fastened to the handwheels, the flexible shafts are fastened to the couplings by pinning the shaft fitting to the spindle on the flexible coupling. Stow Mfg. Co.

### 18—DISTRIBUTION TRANSFORMER features reduced weight, size

Type DT-3 is announced as a dry-type three-phase distribution transformer which features reduced weight and size, is quieter, and has improved appearance. The unit uses inorganic insulation,



basically silicone, and is designed for 150 C temperature rise. Over-all volume of the type DT-3, shown in the circle, is 25 to 51 per cent less than company's previous Class B, 80 C design. Weight reductions range from 17 to 32 per cent, and sound levels are said to be substantially lower. Mechanically-isolated core and coils reduce transmission of noise, permitting connection of rigid conduit to case without causing noise transmission throughout conduit and mounting equipment. Terminal boards and connections are in a compartment in bottom of transformer where low-temperature conductors can be used, since air in this area is at ambient temperature. The units, in either 600- or 2400-v class, are available in ratings from 45 through 300 kva. Westinghouse Electric Corp.

### 19—HOSE ASSEMBLIES of increased flexibility

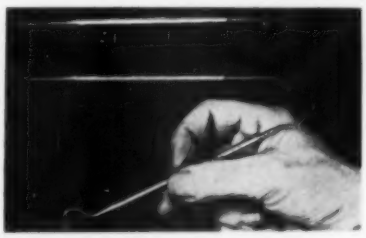
Flex-O-Tube Teflon Hose Assemblies are constructed of smooth extruded Teflon tube with stainless steel wire braided covering. This hose is designed for working pressures to 3000 psi under certain temperature conditions, and temperatures to 500 F when working pressures are not above 1000 psi. The high tensile strength of the assemblies permits smaller outside diameter than many hose materials, effecting savings in weight and space. This characteristic also serves to provide resistance to vibration and to protect against fatigue failures. Conventional straight and elbow fittings and special shapes are available on the hose assemblies — in aluminum alloy lower temperatures and in cadmium plated steel or corrosion resistant stainless steel for high temperature, high pressure use. Operating and shelf life of the hose are declared practically unlimited. It comes in sizes from $\frac{5}{16}$ to $1\frac{1}{4}$ in. Flexonics Corp.

### 20—RADIATOR ANGLE VALVE for 200 lb steam pressure

This heavy duty steam radiator angle valve has angle female inlet and union male outlet, and features oversized bonnet and stem to accommodate high pressure service. A gland follower, double packing and extra large stuffing box are used to provide leakproof performance at 200 lb pressure. Valve will back-seat for repacking under pressure, it is noted. Hammond Brass Works.

### 21—ODOMETER shows how many miles a tractor travels

This new type odometer records distances traveled by this company's track-type tractors. It is made available to owners of these machines as an aid in recording accurate job data. The unit can be easily and inexpensively mounted on both spoke-type and disk-type idlers, it is announced. It is claimed to provide excellent accuracy in the low speed ranges, registering positive mileage in both forward and reverse gears. Accuracy is given as 98 per cent in the lower three gear ranges; 90 per cent in fourth gear. The odometer is inoperative in fifth gear, but since most jobs are performed in the lower speed gears, this instrument supplies a valid reading of working distances covered on most jobs. Caterpillar Tractor Co.



### 22—DENTAL TOOLS can work in the power plant, too

These stainless steel fugitives from a dental office are reported to perform jobs that defy most tools. Where repair and other operations approach miniature or subminiature, the multiform needle ends and nonskid handles of these modified dental explorers aid in manipulating, manual sensing, guiding, selecting, assorting, and even lubricating, where tiny droplets of oil are rolled down the tine into remote bearings and joints. They're called Dentools, and a matched set of three double-headed ones costs less than $5.00. A. Lawrence Karp.

### 23—LOAD SENSING GOVERNOR for engine driven generators

According to manufacturer, this governor senses a load change in the generator output and within 0.01 sec has physically moved the diesel throttle to adjust for the new load. This adjustment is a close approximation; it is followed by a precise adjustment by the speed-sensing element of the governor. The governor provides positive control of the prime mover at all times, it is stated, even in event of failure in the electrical load sensing circuit. Its speed-control element is isochronous, that is, it provides for constant speed of the prime mover, regardless of load, within the capacity of the engine.

Essentially, the governor consists of four elements: a load sensing element placed on the generator output; a rectifier; a speed-control governor; and a servomotor operated trimmer to correct for varying power factor of generator load. The load sensing element is electrically operated. It senses a load change before the change affects the speed of the prime mover, and actuates a solenoid activating the load control which, in turn, adjusts throttle position to approximate new load requirement. The speed-control governor then corrects

This installation in the De Laval Steam Turbine Company in Trenton, N. J. demonstrates how fast load changes, caused by turbine tests, place a grueling load on this pressure controller reducing station for makeup. In the words of the power plant engineer: "The control stability is good and the controller does the job well."

Leslie Pressure Pilot

# Narrow Band Pressure Control *with Stability*

Wide band stability and narrow band proportional control are uniquely combined in the Leslie Control Pilot without need for extra mechanisms to correct for over-sensitivity.

While the pilot responds to small, *definite* pressure changes, it "sorts out" and "ignores" the small, spurious* disturbances common to most control systems. Since it does not follow nor magnify these disturbances, cycling and hunting are eliminated. It is ideal for systems with short lag factors.

*not directly related to process variables but resulting from pipeline friction and turbulence.

### NO COSTLY EXTRAS

The "designed-in" stability and high capacity of Leslie Pressure Control Pilots also eliminates costly "extras" . . . there is no need for automatic reset, valve positioners or filter-type air sets. You get stable, reliable control *without* fussy adjustments and with *ordinary* plant air or water for the operating medium.

### MORE INFORMATION

Ask your Leslie engineer to give you the complete story of the exclusive features that make Leslie Controllers ideal for straight pressure control problems. He's listed in your classified directory under "valves" or "regulators". Send for bulletin described at left.

Send for Bulletin 5303 that gives complete technical data and typical application sketches for the Leslie Pressure Control Pilot.

TRADE LESLIE MARK

## REGULATORS AND CONTROLLERS

LESLIE CO., 301 GRANT AVENUE, LYNDHURST, NEW JERSEY

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**TROUBLED**
*with MOISTURE*
*OIL VAPOR*
*DIRT or SCUM*
*in your COMPRESSED*
*AIR LINES?*
*install*

*Dexter*
**AUTOMATIC**
**SEPARATORS**

Operation of DEXTER AUTOMATIC SEPARATORS is based on the simple principle that when compressed air expands water and oil vapors in the air are precipitated. Practical application of the principle involves the three-fold technical problem of (1) getting necessary expansion without interrupting free flow of air in the Separator; (2) separating the precipitated water and the air so they can not be picked up by the flowing air stream; (3) venting the separated water and oil into the atmosphere. All-welded construction eliminates any need for future replacement parts. No cartridges or filters to replace — 98% eff.

**Type A — Point-of-use Separators** on service outlets in plant systems, on portable compressors. Sizes: ⅛" thru 2".

**Type C — Main Line Separators** equipped with shut-off cock for removal of screen for cleaning without interruption to operation. Sizes: ½" and up.

*Another Dexter Preventative Maintenance Product*
*Send for Full Descriptive Catalog*

**THE LEAVITT MACHINE CO.**
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**For more data circle 528 on post card**

any slight error in fuel requirements.

Changes in position of the speed control element activates a hydraulic servo system that automatically adjusts the electrical trimmer to compensate for the new power factor. The governor is claimed capable of controlling single or multiple synchronized power systems with zero speed regulation and is applicable to engines driving generators up to 300 kw. Woodward Governor Co.

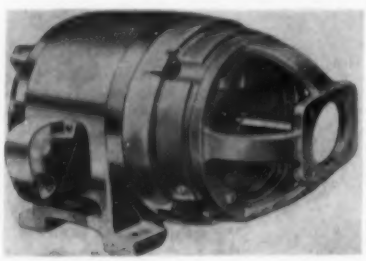
### 24—CLEANING, DE-SCALING unit handles most acid solutions

The Clean-It is a portable cleaning and de-scaling unit for use in refrigeration, air conditioning and heating maintenance. It is designed to handle acid solutions, as well as ordinary solvents, and to clean all types of condensers, coils, cooling towers, air handling units, blowers, and water heaters. The Clean-It consists of two portable, vinyl coated, acid-proof tanks, each with its own acid-proof pump, hoses, and spray or suction fittings. Each pump motor has a reversing switch, and can be used for either suction or pressure. Water-cooled condensers and coil tubes are de-scaled by using the unit to recirculate acid solutions. Sediment settles to bottom of tank and clean solution is pumped back into tubes. The two tanks may be used independently to clean two separate pieces of equipment at one time.

Air-cooled and evaporative condensers, coil surfaces, cooling towers, blowers, etc., are cleaned by using the unit to spray hot detergent or solvent from one tank, while dirty water is vacuumed back into the other. Both tank units are mounted on rubber-tired wheels and have skids for going up or down stairs. Tanks can be filled wherever convenient and then wheeled to equipment to be cleaned. Pumps are designed with plastic cases, rubber impellers and stainless steel shafts. Hastings Air Control, Inc.

### 25—PUMP MOTORS feature an improved coupling method

Designed for hydraulic pumps, these motors are available in dripproof, totally-enclosed, and explosion-proof designs, and incorporate a face type registered bracket for mounting pump on motor. This method of coupling is said to present many advantages: separate base plates or mounting platforms are



not required; a shorter, more compact package is achieved; built-in alignment of pump to motor is provided; and installation time is reduced. Bracket design permits easy access to motor shaft, coupling, and pump mounting bolts.

In the dripproof enclosure, Type H motors are available to 20 hp and Type SC to 125 hp. Totally-enclosed and explosion-proof designs are available in Type J and E to 10 hp, and in Type SD and SE to 125 hp. For double-end pump installations where low pressure-high volume and high pressure-low volume pumping is required, pump motors can be supplied with double end shafts and mounting brackets for supporting two pumps. Data Sheets Sec. 245 give more details on the new units. U. S. Electrical Motors Inc.

### 26—CONTROLLER for remote, automatic valve control

An all-electric rotary valve controller for mounting on the valve stem, the Valvetrol, is designed to provide remote or automatic valve operation with proportional or on-off control. The Valvetrol is a self-contained gear motor with hollow output shaft that receives the valve stem. Stem diameters ¼ to 1 ¼ in. can be accommodated. When used on

rising stem valves the adaptor "swallows" the stem. The Valvetrol has a built-in potentiometer which may provide remote indication of valve position, or be used as part of balanced bridge control. Typical of the latter is use of the unit in automatic proportioning systems where the valve setting must be proportioned to a signal that may originate from liquid level, flow rate, pressure or other source. Manufacturer says Valvetrols can be furnished to provide follow-up accuracies of ±1/25 of 1 per cent; standard low cost models offer accuracies of 1/5 of 1 per cent.

Valvetrols are designed to mount on the valves of many manufacturers. Gear ratios can be had to produce many torques and operating speeds. Selective gear ratios to the potentiometer adapt the unit to valves having from ⅛ to 40 turns to full open. Permanent split capacitor or three-phase Valvetrols come in totally enclosed or explosion proof design. The unit can be furnished mounted on the valve, or is available separately. The Jordan Co.

### 27—CONTROL PILOT for diaphragm actuated valves

The No. 811 and 811-R (reverse acting) are for use with diaphragm actuated regulating valves. The pilot is designed to respond to small variations in controlled pressures in the flow line, and readjust the main regulator for precise throttling of the steam, gas, or liquid flow. Company says it accurately positions diaphragm control valves used either as reducing valves or unloading valves.

According to manufacturer, this pilot is a positive mechanical device developed to eliminate leak-off of hydraulic fluid while still retaining sensitive con-

trol of the diaphragm control valve. It consists basically of a two-way valve actuated by a diaphragm opposed by a loading spring. The adjustable pressure range is broad and settings are readily adjusted, it is pointed out. Controlled pressure ranges are 3–15 psi, 10–40 psi, 25–100 psi. Minimum operating pressure required is 30 psi. Atlas Valve Co.

### 28—PLASTIC VALVE weighs little, resists corrosion

Announced as the first all-plastic Y-globe valve with full flow passage, this rigid polyvinyl chloride valve is designed to provide tight shutoff and flow control of alkalis, acids, inorganic salt solutions and other corrosive fluids used in food, oil, gas, petro-chemical, chemical, paper industries. This valve is claimed non-toxic as well as non-corroding. Its bonnet and gland nut design provides a leak-proof unit, company points out. Because of its sturdy construction, the valve is said to operate successfully at pressures to 150 psi at 75 F. Life of the valve's packing is said to be prolonged through a tapered back seat on stem designed to permit repacking under pressure. The valve is about ⅙ the weight of an equivalent brass or steel valve. It will be available with threaded and solvent-weld socket-type ends for 1-in. pipe. Other sizes are planned. Walworth Co.

### 29—LEVEL RECORDER works at all operating pressures

Automatic compensation of drum level measurements over the entire boiler operating range is declared available in this compensating level recorder. A Bourdon helix compensator continuously readjusts the pen to record true drum level. Operating from drum pressure, the compensator is designed to offset the

effect of any change in specific weight of the water. Thus, it is explained, that at saturation conditions, complete compensation is achieved over entire ranges of level, pressure, and temperature.

This recorder is used on boilers with rated pressure above 900 psig and reheat boilers which must perform many hours below operating pressures during start-up. High and low alarm contacts and/or pneumatic retransmitters may be added. Range of level measurement is from 0–12 in. $H_2O$ to 0–70 in. $H_2O$ at maximum service pressure of 3500 psig. Range of pressure compensator is 0–2500 psig. Product Specification M31–2 gives data on this recorder. Bailey Meter Co.


**Here's how you can SAVE MONEY**
***on VALVE INVENTORY***
***on COSTLY VALVE MAINTENANCE***
***on PRODUCTION LOSSES due to leaky valves . . .***

POWER-DRIVEN
ONE-MAN OPERATED
*Dexter*
VALVE-IN-LINE
**RESEATERS***
*will enable you to set up an effective valve maintenance program*

**FOR GATE TYPE VALVES**
Dexter Gate Valve Reseaters are power driven through a chain and sprocket transmission. Grinding head located on a universal joint automatically seeks and holds the plane of the valve seat, regardless of its angle. Size range: 1" thru 12".

**FOR GLOBE VALVES**
Dexter Globe Valve Reseaters are power driven thru spindles mounted on radial and thrust bearings. Valves are ground from valve manufacturers' reference points. — Grinding heads for all angles. Sizes: ¼" thru 12".

***ADVANTAGES***

- Will grind stainless steel, stellite.
- Grind any valve seat, globe or gate type, regardless of its angle.
- Grind any valve in line regardless of its location, and if accessible.
- Grind a perfect seat in an average grinding time of 4 minutes.
- Reseat in the line 3 to 4 valves in less time than it takes to remove, cut, lap, replace one valve.
- Save up to 400% in man-hours.
- Perfect for welded-in valves.

**Dexter Valve-In-Line Power Driven Reseaters Replace Former Hand-Operated Dexter Valve Reseaters.*

**For More Information Use This Coupon**

**THE LEAVITT MACHINE COMPANY**
**Orange, Mass.**

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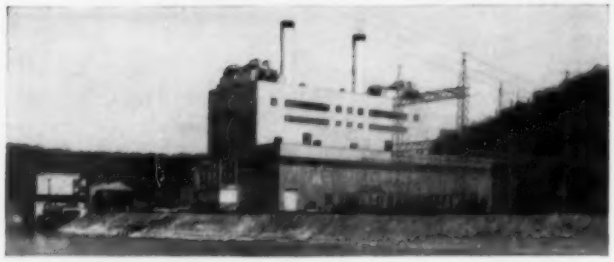
We repair (No.) _____ valves per year
Size range of repaired valves _____

☐ Please have your representative call on me
☐ I would like to see your 17 minute movie (16mm)
☐ Just send me more information

NAME _____
TITLE _____
COMPANY _____
CITY _____
STATE _____

# SHAWVILLE Controls Steam Costs Electronically



Shawville Station, Pennsylvania Electric Company—Gilbert Associates, Engineers. Boiler plant consists of two 894,000 lbs. per hour coal fired reheat units operating at 1900 psig and 1055°F/1005°F.

**At Pennsylvania Electric's new central station near Clearfield, Pa., Republic Electronic Combustion Controls instantaneously correct the firing rate when load changes *first* occur — minimize the effects of load swings almost to the vanishing point—simplify feedwater and steam temperature control—eliminate practically all mechanical inertia, friction and lost motion in master control apparatus—transmit control signals with the speed of light—permit more compact, easier-to-operate control panels.**

● These electronic combustion control features are paying off in lower steam costs for Shawville. In fact, this station produces steam at such low cost that it is able to compete successfully in out-of-state areas over 250 miles away.

At Shawville, electronic circuits instead of pneumatic and mechanical assemblies generate control impulses which are sent to pneumatically powered regulators on boiler auxiliaries. Dead spots and time lags in the master control system due to mechanical lost motion, friction and inertia are almost completely eliminated. And control impulses are transmitted practically instantaneously, thanks again to the speed of electronics.

The master impulse for the combustion control system is derived from steam flow. Air flow to the boiler is directly controlled by this impulse. The signal is then modulated by pressure changes in the steam header and sent to coal mills. Variations in the fuel are automatically compensated for. If steam flow falls below or exceeds pre-set limits, the steam flow-air flow control system is automatically blocked out and conventional fuel flow-air flow control substituted.

This control system compensates for load changes so quickly that their effect on boiler operation is practically nullified. Optimum fuel-air ratio is maintained continuously for maximum combustion efficiency. The feedwater system and superheater temperatures are also stabilized, making these quantities easier to control.

Electronic combustion controls for Unit No. 2 at Shawville are centralized on this benchboard.

## REPUBLIC *Automatic* COMBUSTION CONTROLS

*(Pneumatic or Electronic)*

- ★ for all sizes and types of boilers
- ★ for all methods of fuel firing
- ★ for all load conditions
- ★ for all arrangements of draft

*Write for full details*

**REPUBLIC FLOW METERS CO.**

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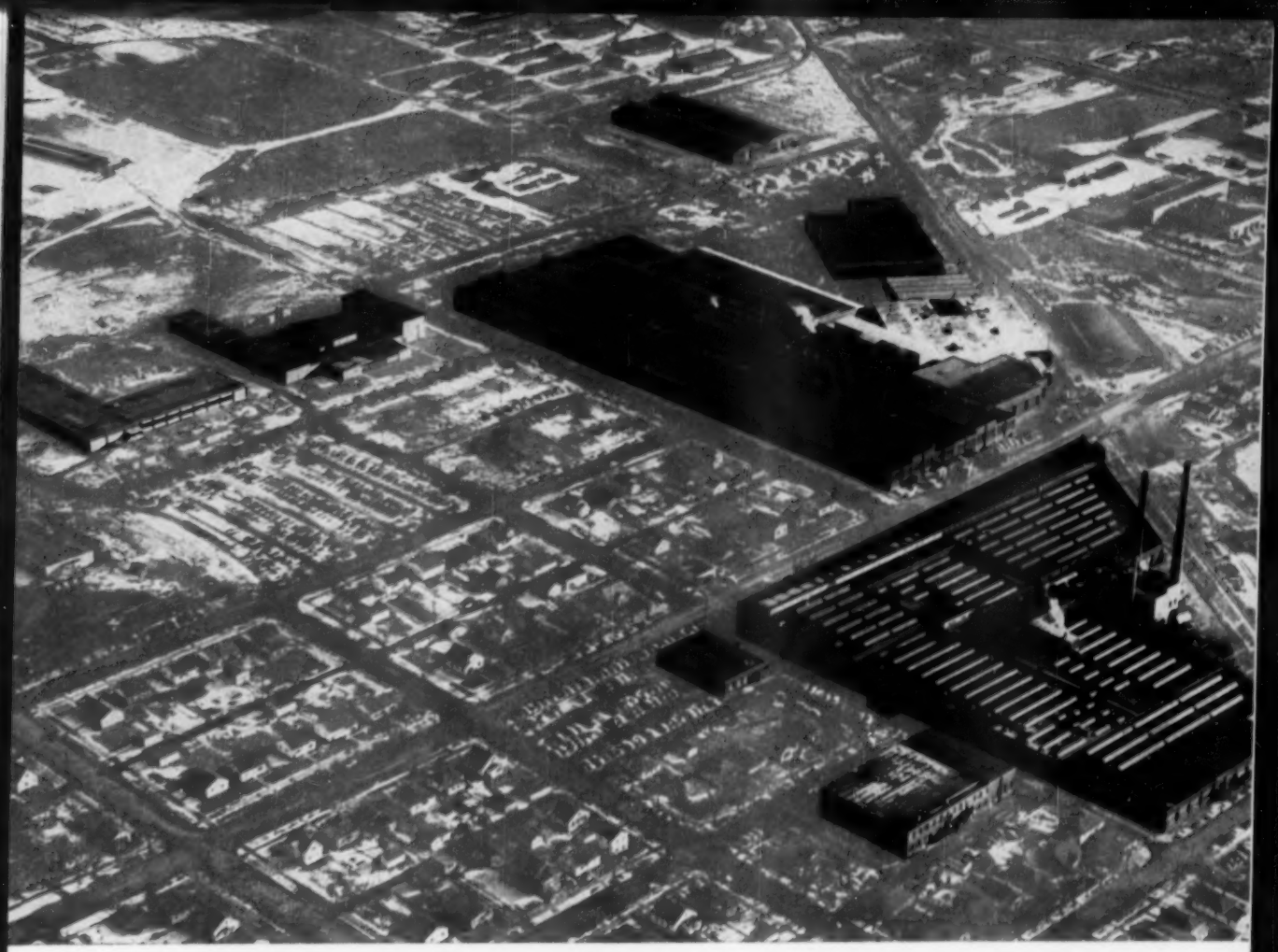

# Trane saves $27,000 a year burning coal the modern way

## Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

## *facts* you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

As part of its current $12 million expansion program at all locations, The Trane Company, La Crosse, Wis., a major air-conditioning and heating equipment manufacturer, has recently modernized its power plant. Steam generating facilities were changed over entirely to a coal-fired operation and a 70,000 lb./hr. boiler was added. Coal and ash handling is automatic.

Trane has found that burning coal the modern way pays off in several ways. Overall cost of steam generation is cheaper. Fuel supply is readily available and dependable. And fuel cost savings amount to 25% over the next most economical fuel, totaling about $27,000 a year for the La Crosse plant alone.

*For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.*

BITUMINOUS COAL INSTITUTE
Southern Building • Washington 5, D. C.

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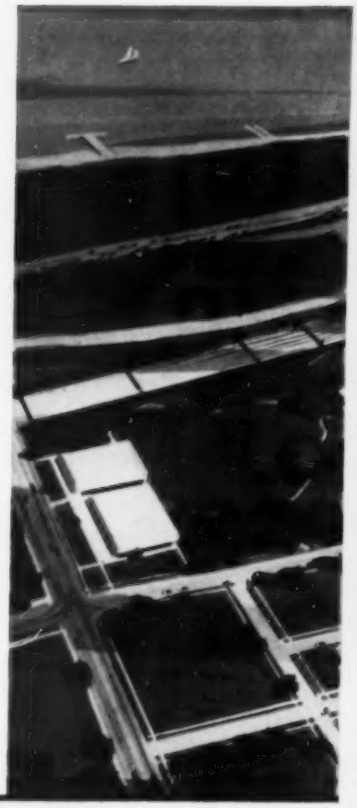
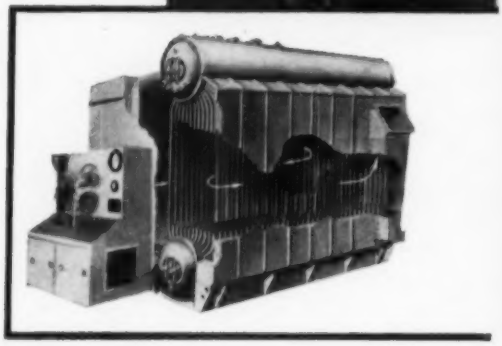
# Chicago's newest is served



Located on a 100 acre site overlooking Lake Michigan, Chicago's newest planned community, the Lake Meadows project, offers gracious living within the confines of a large city. Owned and managed by the New York Life Insurance Company, Lake Meadows provides distinctively appointed apartments, spacious grounds, a modern shopping center, ample parking facilities, yet is within minutes of the heart of the city. When completed, this project will house 2000 families and will include an eight acre park. In addition, construction has already begun on a new elementary school located on a two acre plot adjacent to the housing development.

A project of this size requires considerable steam capacity to provide ample heat and hot water and to perform the many other services required. To do the job, the New York Life Insurance Company originally selected 3 C-E Package Boilers, Type VP. Later, as new housing units were added, 2 additional VP Boilers were installed. Their outstanding performance and efficient, trouble-free operation is evidenced by the repeat order placed with Combustion for the final 2 units.

VP Boiler Catalogs are available on request.



Cutaway view of typical VP Boiler. For capacities from 4,000 to 40,000 lb of steam per hr. Pressures to 500 psi. Oil or gas fuel.

**COMBUSTION**

**Combustion Engineering Building**

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS.

# planned community
## by C-E Boilers

Architect's rendering of the Lake Meadows project. Skidmore, Owings and Merrill, Architects.

Firing aisle of the Lake Meadows boiler room showing three of the five C-E Package Boilers, Type VP.

**ENGINEERING**

**200 Madison Avenue, New York 16, N. Y.**

C-E

8-986

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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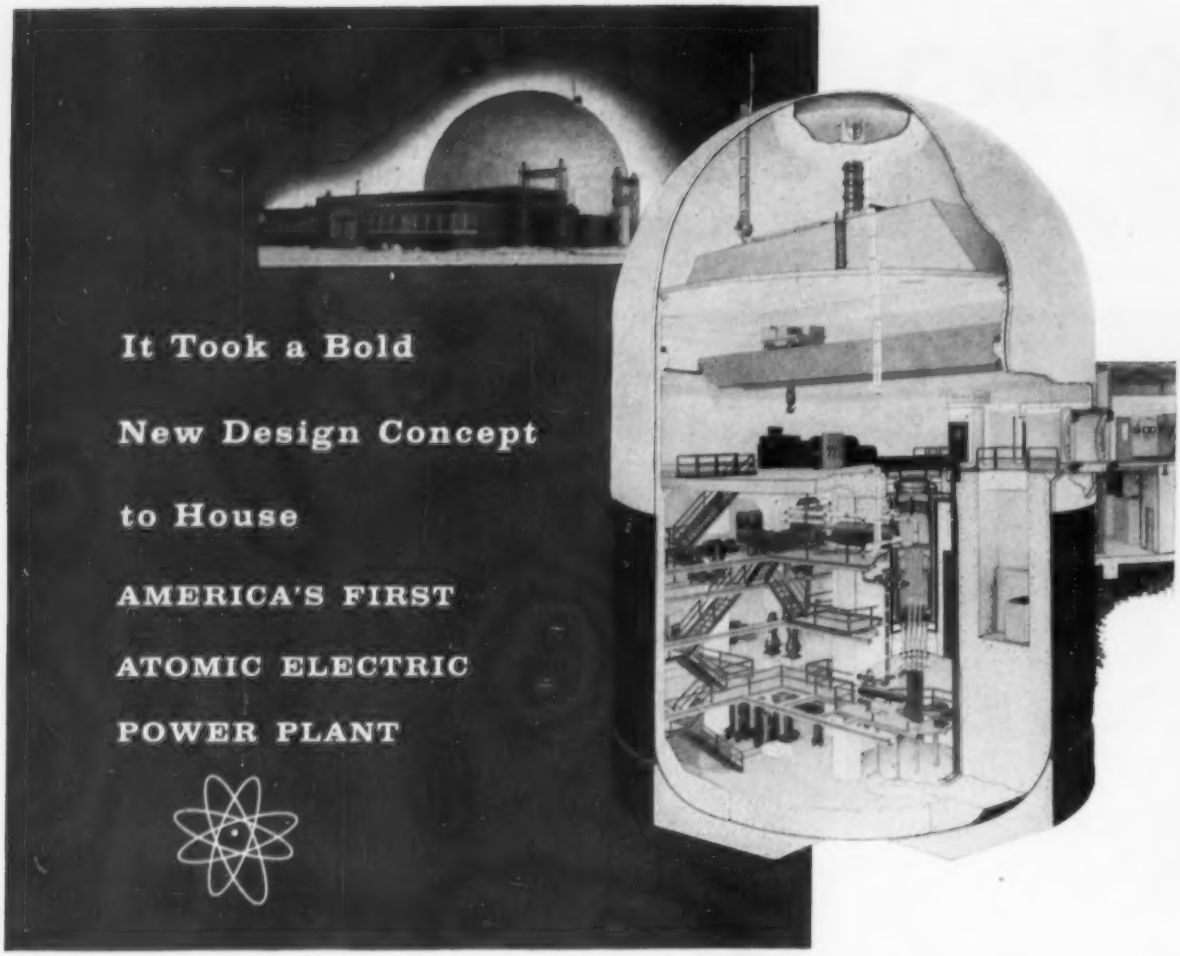


How do you house an atomic electric power plant? Dig a hole five stories down. Erect a giant ten-story welded steel "containment vessel." Seal it off air-tight, and you have one of the largest pressure vessels man has ever been called on to build.

That's the story, over-simplified, of the unique housing required for America's first nuclear-powered electric plant, the Experimental Boiling Water Reactor, at Argonne National Laboratory, Lemont, Illinois.

In our practical, efficient world of engineering, there is a sound structural reason for the unusual dome-shaped building, now recognized by everyone as the symbol of atomic-power-for-peace.

Radioactive steam and gases must be contained within the system. The precautions necessary demanded an air-tight building, 80 feet in diameter by 119 feet high.

This giant welded steel structure, designed to withstand a pressure of 15 pounds per square inch above gage pressure, was made concave throughout, with a semi-ellipsoid bottom and a hemispheric top.

Upon completion, the half-million cubic foot shell was tested for air-tightness. Never before had so large a welded structure required such thorough testing against air loss.

Graver's skills, backed by a century of experience, were called upon to fabricate, erect and test this unique steel structure.

Graver's research department devised the special air-tightness testing procedures. Graver fabricated all sealing devices—the access air-locks, bulkheads and doors, and the two water-demineralizing systems. It also furnished the saucer-shaped 15,000 gallon water tank suspended under the dome.

This application of Graver's skills in the fabrication and erection of America's first atomic power plant is indicative of Graver's readiness to help you fulfill your plans for the future, no matter how unusual or exacting the requirements.

*Building for the Future on 100 Years of Craftsmanship in Steels and Alloys*

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EAST CHICAGO, INDIANA • NEW YORK • PHILADELPHIA • EDGE MOOR, DELAWARE
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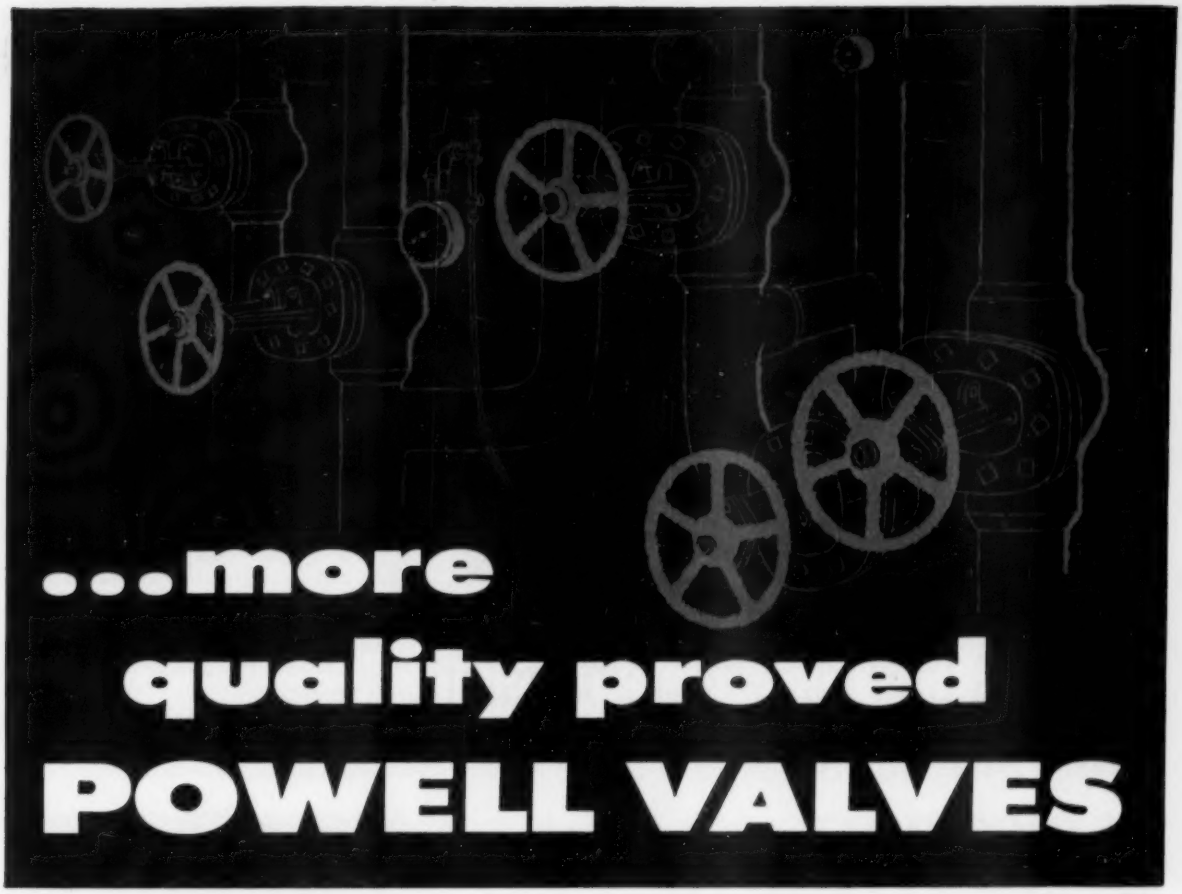

# ...more quality proved POWELL VALVES

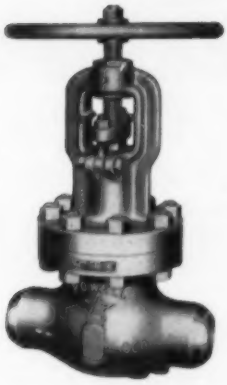

Fig. 6031S-WE—600-Pound Steel Globe Valve for Steam Service. Outside Screw Stem and Yoke.

Fig. 19003—Powell Steel Pressure Seal Gate Valve for 900 Pounds W.S.P.

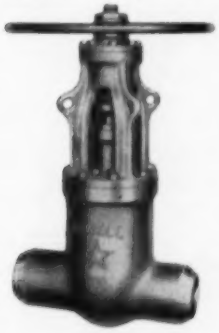

Fig. 2467—Small 300-Pound Stainless Steel O.S.& Y. Gate Valve. For handling boiler feed water treating solutions.

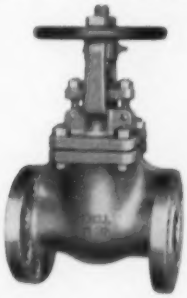

Fig. 1793—Iron Body Bronze Mounted O.S.& Y. Gate Valve for 125 Pounds W.S.P.

## made with quality proved materials

Consult your Powell Valve Distributor for full facts about quality proved bronze, iron, steel, and corrosion-resistant valves. For every flow control problem—there is a Powell Valve to solve it . . . *better.*

**THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR**

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Consulting Engineers: Seelye, Stevenson, Value & Knecht. Heating Contractors: Almirall & Co., Inc. and Norman Heating Co., Inc.; Eugene J. Brandt & Co., Inc.

LARGE TRENCH AT IDLEWILD shows one expansion loop in foreground and another in background. Note large pipes for chilled water lines running outside of the walled trench containing the high temperature hot water system. The control tower is in the center of the photograph, and the new International Arrival Building is at the right of the tower. The bags of GILSULATE are slid down boards into the trench.

# $90,000,000 Idlewild expansion program uses 1515 tons of GILSULATE to protect 7 miles of pipe

### New York International Airport Has One of World's Largest High Temperature Hot Water Systems

By 1960 "Terminal City" will be a completed reality at New York International Airport. This gigantic undertaking comprises 655 acres and will be equipped to handle 140 aircraft at one time. Estimated cost of the project is $90,000,000.

Running from a central heating plant to each of the projected buildings in Terminal City is one of the world's largest non-military high temperature hot water systems ever designed. This system, operating at 380°F on the supply and 240°F on the return lines, includes 38,774 feet of pipe (7.34 miles!), virtually all of which is protected with 1515 tons of Type B GILSULATE. In this gigantic system, expansion loops alone total almost one mile!

Big job or small job, GILSULATE offers the same unique protection for underground hot pipes—and the same opportunity for on-the-job savings. GILSULATE is easy to install; it calls for no trained fitters or applicators, no special installing equipment. So whether *your* piping job is large or small, you'll find that GILSULATE fits right into your specification picture—at a lower cost per installed linear foot than any other underground hot pipe insulation.

For more complete information, see your local GILSULATE distributor, or write any of our offices listed below.

Artist's sketch of Terminal City showing proposed buildings and extent of high temperature hot water system.

**FACTS ABOUT GILSULATE**

1. **EASY TO USE**—just pour and tamp...pipe heat does the rest.
2. **FORMS 3 ZONES** of protection against heat loss and all hazards commonly encountered by buried hot pipes.
3. **NEEDS NO HOUSING OR MECHANICAL SHEATHS:** no mixing, special handling or equipment.
4. **ONLY NEEDS NORMAL PIPE SPACING:** for multiple pipe or cramped conditions.
5. **THREE TYPES AVAILABLE:**
   Type A for 220°-300°F. temp. range
   Type B for 300°-385°F. temp. range
   Type C for 385°-520°F. temp. range

**AMERICAN GILSONITE COMPANY**
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The Triple-Zone Insulation System for Lifetime Protection of Underground Hot Pipes

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## UNCERTAIN OPERATING COSTS BOTHER YOU?

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# *long range economy fuel*

You'll win in the long run by burning Bituminous! Today and tomorrow, supply is unlimited and the vast reserves are right on the threshold of the major manufacturing centers. Bituminous, too, has the highest potential for cost improvement among competing industrial fuels. Year in and year out new methods and machines are designed to control costs and improve burning efficiency.

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**BITUMINOUS COALS FOR EVERY PURPOSE**

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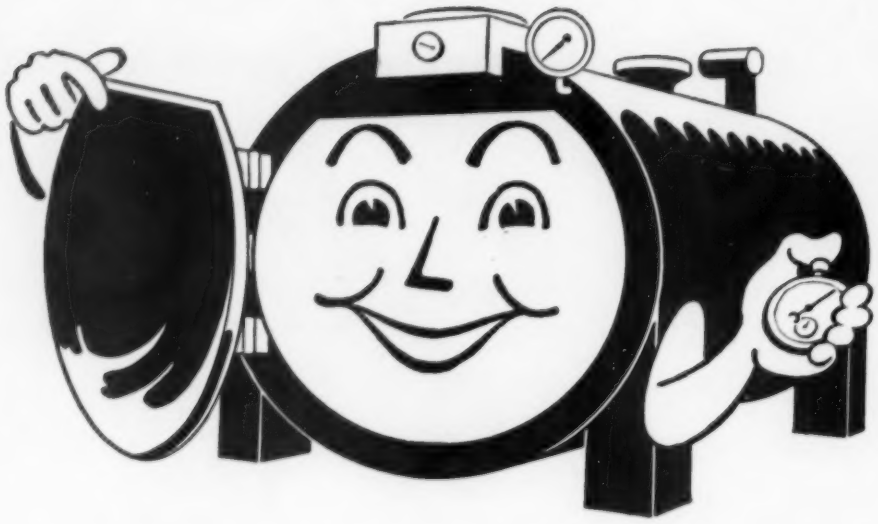


# The Boiler that saves maintenance time

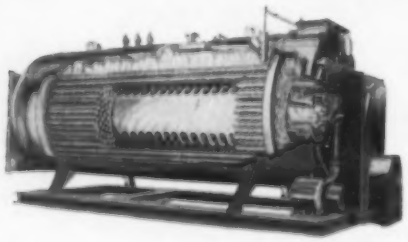
It's always easy to gain access to a Continental Automatic Boiler. For routine servicing, all doors — front, rear, and burner — are hinged. Simplified design eliminates need for refractory baffles or partitions which might burn out, leak, and cause short circuit of gases.

Low maintenance is one of the important cost-saving features of every Continental Automatic Boiler. Controls are simplified and dependable, requiring practically no attention. Heating surfaces stay clean, because of Continental's free, rapid water circulation. And openings are provided to facilitate inspection of steam and water space.

Continental's simple, practical two-pass design with the exclusive "spinning gas" feature means that all return tubes do equal work at equal temperatures, last longer, provide full access to all fire surfaces. And every Continental Automatic Boiler is fire-tested before shipment, to insure a guaranteed efficiency in excess of 80%, and a long, trouble-free, low-maintenance life. For more details, ask for Bulletin BE-3.

**BOILER ENGINEERING & SUPPLY COMPANY, INC.**
**3 Manavon Street, Phoenixville, Pa.**

The Continental AUTOMATIC BOILER



Cut-away view of typical Series A Continental Automatic Boiler, firing oil and/or gas.

A HALF CENTURY OF BOILER MANUFACTURING EXPERIENCE

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# Here's why you get that extra measure of performance from **BRIDGEPORT** condenser tubes

1 ELECTRONIC SPECTOGRAPH analyzes the composition of alloys from which condenser and heat exchanger tubes are made. From the very beginning, product performance and customer satisfaction are essential. Maintaining high metallurgical standards means high tube quality—it starts here.

*From spectograph to shipping, every step of Bridgeport Condenser Tube manufacture is carefully and closely controlled. Research, experience, skill and attention to your individual needs are integral qualities of every Bridgeport Condenser Tube that pay off in performance. Put them to work for you by calling your local Bridgeport Sales Office.*

2 MODERN DRAW BENCH (its size speaks for itself) and others of the same "caliber" bring copper, alloy condenser and heat exchanger tubes down to exact, uniform dimensions.

3 HIGH-TEMPERATURE ANNEALING FURNACES give tubes the proper physical characteristics.

4 CLOSE INSPECTION of diameter, wall thickness and surface finish is made—another step that assures you that your Bridgeport tubes are made to flawless standards.

5 CORROSION RESEARCH is continuous at Bridgeport Corrosion Laboratories. Here the many alloys used under all corrosive conditions are tested; new alloys are developed from the knowledge and experience acquired here and in the field.

**BRIDGEPORT CONDENSER TUBES**

**Bridgeport Brass Company • Bridgeport 2, Conn. • Offices in Principal Cities**

*In Canada: Noranda Copper and Brass Limited, Montreal*

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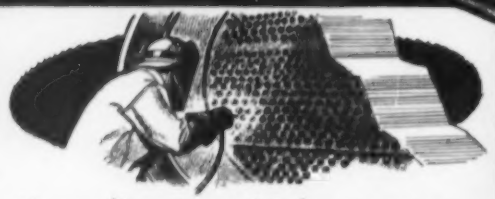
# POWER POINTERS

## IT'S CURTAINS

FOR FLUE-GAS CONTROL PROBLEMS

### ...0.005-INCH INCONEL ALLOY CURTAINS

FLUE GASES...UP TO 800°F...WERE TOO HOT FOR REGULAR ASBESTOS DAMPER CURTAINS IN ONE ELECTRIC COMPANY BOILER. SO THE CURTAIN MANUFACTURER DESIGNED ONE MADE OF METAL. IT HAS THE SAME WINDOW-SHADE ACTION; THE SAME FLEXIBILITY. BUT IT'S MADE OF 0.005-INCH THICK INCONEL* NICKEL-CHROMIUM ALLOY SHEET. THREE YEARS OF ASH-LADEN STACK GASES HAVEN'T CORRODED OR WORN THE INCONEL CURTAIN TO ANY NOTICEABLE DEGREE.



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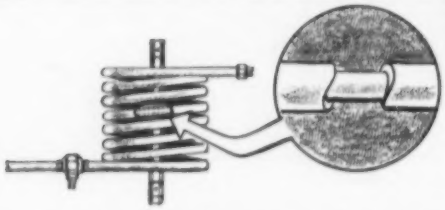

### NEW INNER TUBE FOR STEAM SAMPLER GIVES EXTRA "MILEAGE"

AT A MID-WESTERN POWER PLANT, STRESS-CORROSION CRACKING RUINED INNER TUBES OF HIGH-TEMPERATURE STEAM SAMPLER COILS IN SIX MONTHS OR LESS. A SWITCH TO INCONEL ALLOY HAS TRIPLED INNER TUBE "MILEAGE" EVEN THOUGH THE SAME THERMAL SHOCK AND CORROSIVE CONDITIONS EXIST.

### WHAT'S YOUR METAL PROBLEM?

MAYBE AN INCO NICKEL ALLOY CAN REINFORCE YOUR INGENUITY AND LEAD TO A QUICK SOLUTION. TO EXPLORE THE POSSIBILITIES, WRITE FOR INCO BULLETINS COVERING THE ENGINEERING PROPERTIES OF INCONEL AND INCONEL 'X' ALLOYS AND MONEL AND 'K' MONEL ALLOYS.

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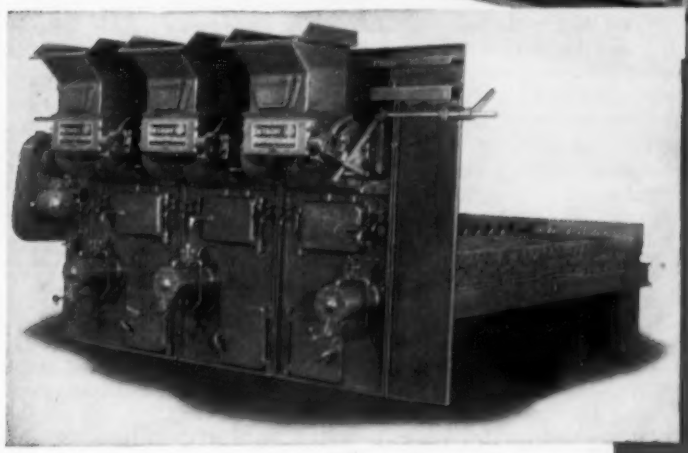

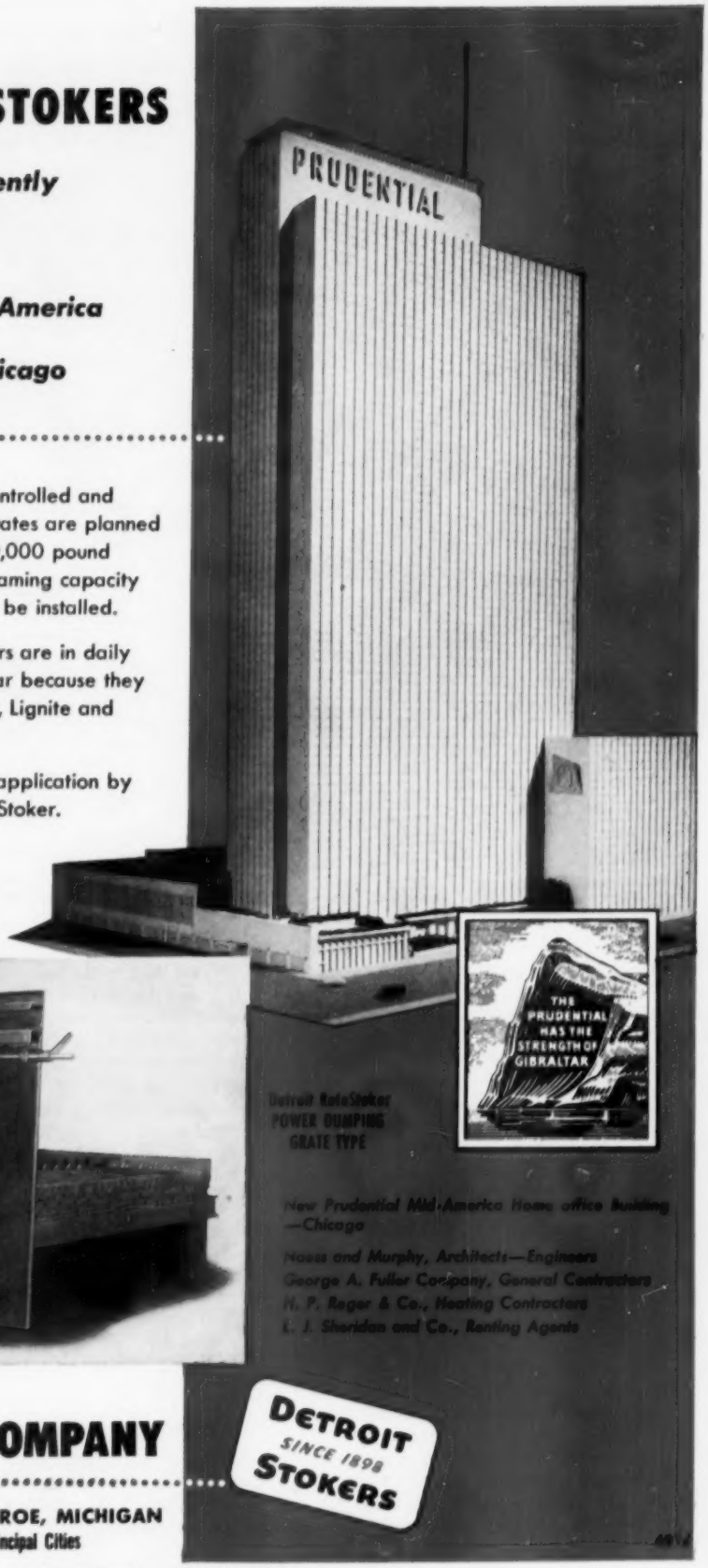


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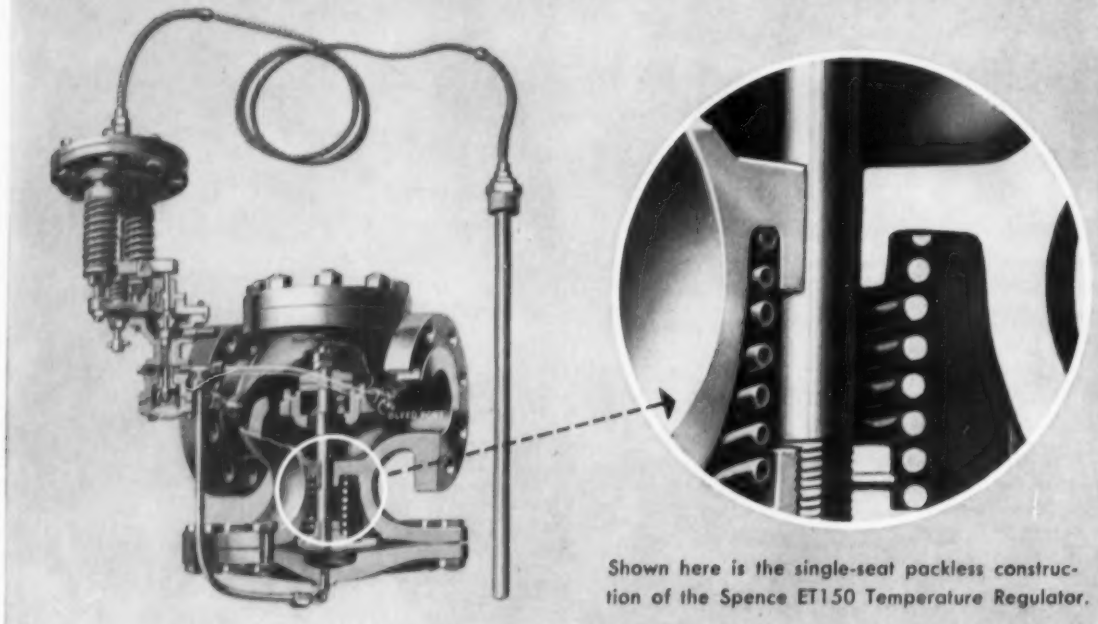
**VALVE TIPS:**

# *Advantages of Packless Construction in Temperature Regulating Valves*



Shown here is the single-seat packless construction of the Spence ET150 Temperature Regulator.

One of the biggest headaches in regulating valve maintenance is repacking stuffing boxes.

How often a valve needs repacking, how much time it takes, and the cost of the system downtime all vary with the construction of the regulator and the service it's used for. No matter how you calculate all these variables it's still a headache—and an expensive one.

In the temperature regulator shown above (Spence Type ET150) stuffing boxes are eliminated. This is done by what is known as "balanced" diaphragm construction. You can see in the cutaway drawing that pressure is applied to both sides of the large metal diaphragm. The upper side is exposed to delivery steam pressure and the lower side is exposed to loading pressure applied by the pilot. When the pilot closes, both delivery pressure and loading pressure are equalized through the bleedport and connecting tubing.

This construction not only does away with repacking problems, but it makes possible additional savings as well. For example, you will note in the sectional blow-up that this design eliminates a closely fitted stem and guide. Dirt or other foreign matter doesn't have much of a chance to lodge between these parts and cause sticking.

Another cause of binding or sticking, uneven expansion of closely fitted parts, is also eliminated with this design. In addition, valve stem wear is reduced for the same reason.

Lower maintenance is not the only advantage of this packless construction. Accuracy of regulation is also improved because friction due to a stuffing box, dirt, or uneven expansion is not a problem. The large, *balanced* metal diaphragm is more sensitive to slight changes in pressure.

## Guaranteed Not To Wiredraw

If seats and discs are cut by steam (wiredrawn) the loss of steam through these grooves can be another expensive item — directly charged against the regulating valve. Fortunately, you can eliminate these costly leaks by specifying a temperature regulator that is *guaranteed not to wiredraw.*

Spence makes such a guarantee because their seats and discs are made of SECO Metal. Over 20 years experience with this special alloy has failed to produce a single case where a SECO Metal seat or disc had been cut by steam. All that's required is an approved strainer located ahead of the regulating valve. Expensive steam leaks just can't happen with this combination of SECO Metal and single-seat design.

If you would like to have more information on Spence Temperature Regulators, drop us a line and ask for Bulletin T150. It gives more detailed information on these and other Spence design features. Piping layouts and helpful information on the installation of temperature regulators are also included. Write for your copy today.

SPENCE ENGINEERING COMPANY, INC.
*Walden, New York*

OS 140

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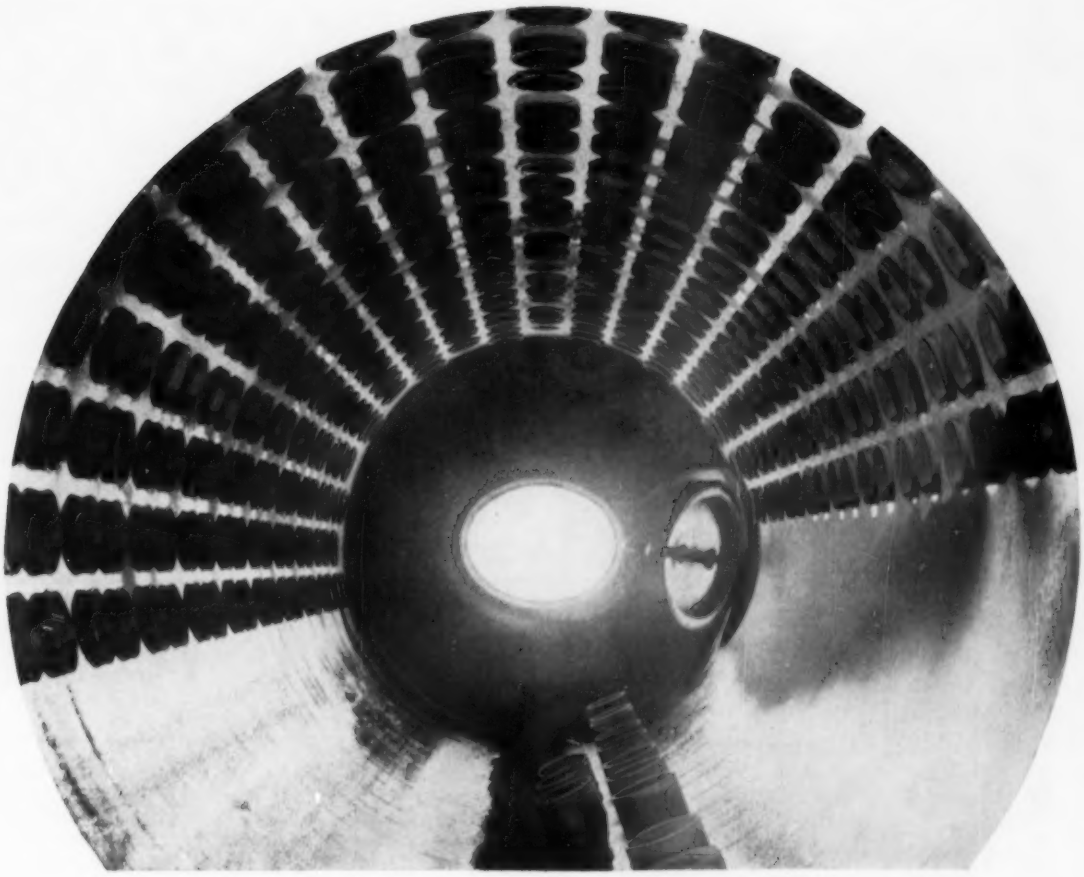

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When this mud drum was opened for inspection, it looked just as everyone expected it would—clean as a whistle, completely free of sludge and scale—after nine months of treatment with Dearborn Formula 659. That's product dependability.

Formula 659 contains a patented* Dearborn Polyamide Anti-Foam that provides protection throughout the entire water-steam cycle. In addition to improving steam quality, Formula 659 also conditions sludge, reduces blowdown requirements, and controls corrosion.

Compatible with other water treating reagents, Formula 659 is a neutral product which imparts no alkalinity to boiler water—nor will it increase carbon dioxide content of steam.

Formula 659 will mean important savings in your plant—see your Dearborn Engineer.

*U.S. Pat. No. RE-23085*

## HOW FORMULA 659 WORKS

**FORMULA 659** improves steam quality by reducing carry-over to a minimum.

**FORMULA 659** keeps sludge in a fluid, non-adherent form.

**FORMULA 659** permits higher boiler water concentrations, thus reducing blowdown.

**FORMULA 659** helps protect against corrosion in the water-steam cycle.

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# boiler water levels now easier to **see**... easier to **read**

Whatever the boiler pressure, high or low, YARWAY Remote Indicators give accurate, instant, eye level boiler water level readings at any convenient plant location.

Boiler Code Case No. 1155* says in part, "... two independent remote level indicators of the compensated manometric type may be used instead of one of two required gage glasses for boiler drum water level indication in the case of power boilers with all drum safety valves set at or above 900 psi..."

YARWAY Remote Liquid Level Indicators fill the bill—and feature a "wide vision" face that makes reading easier from any angle.

Accurate—because indicator is actuated by the boiler water itself—by the pressure differential between a constant head and the varying head of water in the boiler drum.

Also use YARWAY Remote Indicators on heaters of various types.

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Yarway Remote Hi-Lo Alarm Signals—lights or horns—can be used with Yarway Remote Liquid Level Indicator and placed at any location in the plant.

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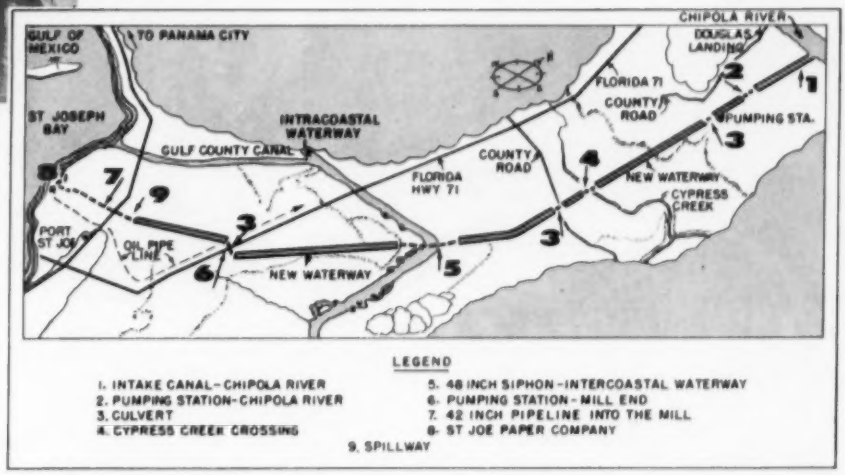
# St. Joe Paper Gets New Water By Long Distance

Fig. 1. The St. Joe mill at one end of the canal, Chipola River (right) at the other. Pumps at points 2 and 6




By C. D. BASSETT*
and
A. A. CUMMINS *

**Unique canal system, cut 17 miles across country from plant to river, has made possible the new water supply needed by the St. Joe Paper Company for an 800-ton expansion to their mill. Results prove good**

IN 1951 the St. Joe Paper Co decided on an 800-ton expansion to their paper mill at Port St. Joe, Fla., which was then operating at a capacity of something over 400 tons per day. The plant was using about 6000 gpm of well water secured from eight wells 150 ft deep and eight wells 600 ft deep, the water having a hardness of about 13 grains.

Since the water level in these wells had been materially lowered by continuous use, it seemed quite certain that sufficient quantities of satisfactory water for the 800-ton expansion could not be obtained from wells. After some consideration it was decided to bring the mill water from the Chipola River, 18 miles away.

The first consideration was to make this a pipe line for the full distance, but studies of the possibilities by the engineers indicated the desirability of a canal. This desirability was enhanced by the fact that the company owned all of the land over which the canal would pass and also had the equipment with which this canal could be dug. Also, there was sufficient grade, taken altogether, so that the depth of water could be varied in the canal to increase its capacity — with very little additional expense — from the proposed requirements of 30,000,000 gal per day for the pipe line to almost 60,000,000 with the canal.

Most of the drop in grade was between the Chipola River and the Intracoastal Canal, for a distance of about ten miles; and the making of this part of the canal was accepted without question. However, the matter of the distance of seven miles from the Intracoastal Canal to the plant pump house afforded very little grade, with some deep cuts and a considerable amount of quicksand, with the canal passing through swamps. It was strongly argued by some that the canal would fill up due to the quicksand; that it did not have adequate slope for flow of water, and that the water would be contaminated by infiltration from adjacent swamps.

However, the management decided on the canal for the full length, except for culverts, the pipe lines under Cypress Creek and the Intracoastal Canal, and the pipe line from the mill pump house to the mill. The drawing in Fig. 1 shows the plan of the canal and structures.

### Record of Results

Four years of operation have justified this decision in that:

1. Plant has had a supply of excellent water up to the present needs of 34,000,000 gal per day with reserve capacity remaining.

2. Canal has been used as a treating basin with the result that, while the water is quite turbid when it enters the canal from the river, yet after treatment and when it reaches the lower pump house, it is clear. There has been no detrimental infiltration of water from adjacent swamps, nor has there been any sloughing from the banks of the canal to shut off the flow.

3. In general, difficulties have been very few. There has been some growth in the section of the canal between the Intracoastal Canal and the Chipola River. While not serious it will require periodic removal. To date no growth needing removal has occurred in the canal length between the

* Both of Cummins & Barnard, Inc., Engineers

**For photographs of the canal under construction, turn the page** ➡

Fig. 2. Caterpillar bulldozers aided by Northwest 95 excavated to ground water level, then cross section contour was completed with draglines. 1,500,000 cu yd were moved

Figs. 3 and 4. Views of intake canal at Chipola River, and diversion dam at Cypress Creek crossing built on the alignment of the 48-in. cast iron pipe carrying canal water across

Intracoastal Canal and the paper mill.

It is recognized that the canal capacity can be practically doubled above the present water use by adding another pump at Chipola River, space for which was provided, and by possibly putting another pipe line under the Intracoastal Canal. This will provide water for possible future expansion or diversification.

The canal and its several structures were financed by the paper company, and built entirely on company property. The canal excavation was done by the company's forces and the structures by the Tidewater Construction Corp., general contractor. It set a pattern for solving water supply problems by industrial plants that has been since followed in the deep South in some instances.

### Construction Highlights

Although the canal between the Chipola River pump house and the paper mill on St. Joe Bay generally traverses level country, the excavation figures were impressive.

More than 1,500,000 cu yd of earth were moved and used for wide dikes along both sides of the canal, the dikes serving as access roadway throughout considerable of the waterway's length. Also, for about seven miles, between the Intracoastal Waterway and the mill, where the excavation in places reached depths of 15 to 20 ft in fine sand, the cross section was made wide and with flat side slopes to prevent sloughing and blocking of the canal.

The excavation technique in general was to excavate to ground water level or somewhat below, with bulldozers, and then to complete the cross section contour with drag lines. Figure 2 shows how the bulldozers worked ahead of the draglines in digging the canal.

Some of the conditions for which special structures were required included the Intracoastal Waterway, where an inverted siphon with head walls was installed; Cypress Creek, crossed by pipe line between concrete head walls; several major highways, where submerged culverts with head walls were utilized; a diversion dam and intake structure at Cypress Creek; and intake structures at several woodlands' drains, for using available surface waters.

At the Chipola River an intake canal, about 1000 ft long, leads to the river pump house. This is shown in Fig. 3. This intake takes out at right angles to the river and was dug to the same elevation as the river bottom at this point, which was two ft below sea level. The lowest water at this point, estimated by Smith and Gillespie of Jacksonville, Fla., who made a report on the water supply, had been about five feet above sea level.

The pump house floor was established at sea level, the intake structure inlet at – 1.0 and the inlet pipe to the pump suction at – 0.25 ft. Two 13,500 gpm capacity pumps were installed with space for a third; 40,500 gpm would give a total capacity of 58,320,000 per day. Original requirements were estimated at 30 mgd; 34 mgd are now being used.

Pumps used at the Chipola River pump house raise the water to the supply canal, the bottom of which at its beginning is 17.6 ft above sea level. At the paper mill end of the canal, a second pump house sends the water into the plant. The bottom of the canal at the lower pump house is at sea level.

Pumps of about the same capacity were installed at this pump house. Here, also, diversion works were installed to spill excess water from the canal if and when it occurs. A spillway was also constructed close to the intake head wall of the Intracoastal Waterway siphon.

The hydraulic gradient available between the Intracoastal Canal and the mill pump house (a distance of seven miles) was two feet. Four-tenths of a foot was allocated to the pipe under highway No. 71 and the balance to the canal. The large canal section made possible the use of such a low hydraulic gradient.

### Topography and Soil

Geographically the canal is entirely within Gulf County, northwest Florida, and the Intracoastal Waterway crossing is at approximately ten miles from the Chipola River. North of the Waterway the soil is, to a considerable extent, a very stable clay. Because of this, and adequate slope, the trapezoidal cross section was kept small throughout this length.

South of the Waterway the soil is quite sandy and includes dunes and swamps. Through this length the trapezoidal cross section was made very large to permit washing of banks without reducing canal capacity below desired amount.

Before making a decision between the open canal and concrete pipe, several large test pits were dug along the canal's surveyed line where the soil was particularly sandy. These test pits filled rapidly with ground

Fig. 5. Pipe line about completed under Intracoastal Waterway. 1-in. cable was threaded through blocks, and pipe was pulled to this position by tractor on opposite side of the canal

Figs. 6 and 7. View of same spot shown in Fig. 5, early in 1957. Lower view shows canal just below point shown in Fig. 6. Taken early in 1957. The water here is not yet treated

water and were watched and cross-sectioned by the engineers for several weeks to determine the results of wave action and sloughing on the sides of the pits.

Because of the wide cross section being considered for this length of the canal, the test pit results indicated that for a long time the sloughing at the canal sides would not likely be sufficient to impede the flow of water through design cross section, even through the deepest cuts. After four years the banks have consolidated and no serious filling-in has occurred.

Bridges across the canal were erected by the Woodlands Division of the St. Joe Paper Co as required for firelanes. They are heavy timber structures including the piling, which was jetted down with portable water pumps. The 350-ft long diversion dam or weir at Cypress Creek, which can spill water into the canal at high water season, is also a heavy timber structure built by the Woodlands Division and was built on the alignment of the 48-in. c.i. pipe carrying the canal water across Cypress Creek. This is shown in Fig. 4.

The siphon, Cypress Creek crossing, and culverts are all large-diameter cast iron pipe. The culverts are plain bell and spigot type. The 470-ft Cypress Creek crossing and the head wall connections at the Waterway crossing are a flanged mechanical joint type of pipe called the Double X. That part of the Waterway siphon which was laid across the Waterway bottom uses a ball and socket Molox joint, so that the pipe can conform to the contour of the channel bottom.

Another operational benefit from this large canal section was a large reservoir of water between the Intracoastal Canal and the mill pump house. The water, for instance, can be treated for precipitation of organic material and silt in this reservoir, the best spots for introducing chemicals being at the inlet to the Intracoastal Canal siphon about seven miles from the plant pump house, or at the Highway No. 71 crossing about three miles. Introduction of chemicals is now at the Highway No. 71 crossing.

### Water Treatment

The comparatively high velocity through the 1100 ft of inverted siphon pipe would ensure excellent mixing, and the large cross section of canal below the siphon gives a very low velocity for settling out of sludge, and the extent of the canal a large storage capacity.

The water when it reaches the mill pump house is clear and of such good quality that very little additional treatment is needed even for that part used domestically by the town of Port St. Joe. Hardness is about three grains per gallon.

The canal water is treated at Highway 71 for the purposes of precipitation of suspended solids and maintenance of a pH of 7.4. The following chemicals are being fed at this point: aluminum sulphate, 30 ppm; sodium aluminate, 2 to 3 ppm; sodium hydroxide, as required.

In the beginning a weir was installed about 600 ft or 700 ft down stream from the Highway No. 71 crossing, with the idea of retaining the sludge which would be precipitated after treatment; also, a network of pipe was put in and connected to a pump to run intermittently for removal of this material. The installation as made was not adequate, and was abandoned.

The sludge has been building up in the canal for some time, but recently a small dredge was put into operation for its removal. The location of the sludge is within definite limits and its lower limit was still more than a mile from the mill pump house so that the water there had not been affected.

This method of removal of sludge appears to have proved quite practical, and after the quantity which has accumulated has been pumped out, it is planned to do all the pumping within the 600 ft ± range between Highway 71 where the treating plant is and the weir. It is not known exactly what per cent of the time the dredge will have to be operated, but probably at most, half the time and possibly less. The dredge is small and is being handled by two men.

### Pumping

Present maximum flow in the new water supply canal is roughly 24,000 gpm. However, the practical capability of the canal is about 1.7 that much, with water velocities still remaining below the silt-carrying limit. The pump house intake structure is deep enough to accommodate all known variations in water level. The preliminary report indicated that water level variation had been between elevation 5.0 and 23.5.

Traveling screens protect the pumps from debris, although the centrifugal pumps are capable of passing rather large solids if necessary. The pumps are installed in a dry room with the bell mouth intake

pipes extending through the wall and down into the chamber behind the screens. A similar arrangement of equipment is used at the plant pump house.

Pumps at the plant pump house are electric motor driven through fluid couplings since these motors are within a mile of the mill power plant. However, at the river pump house 18 miles away from the power house, 114 bhp diesel engines drive the pumps. REA power is used only for lighting and small auxiliary motor drives at the Chipola River pump house. Figure 8 shows the part of the pump house above ground and the top of the 30-ft high traveling screens. Figure 9 shows the diesel engine driven pumps. These have been operated four years and only recently was one overhauled, little being found wrong. Water level in the intake at time of this picture was at elevation 7.0 ft but has been as low as 2.5 ft.

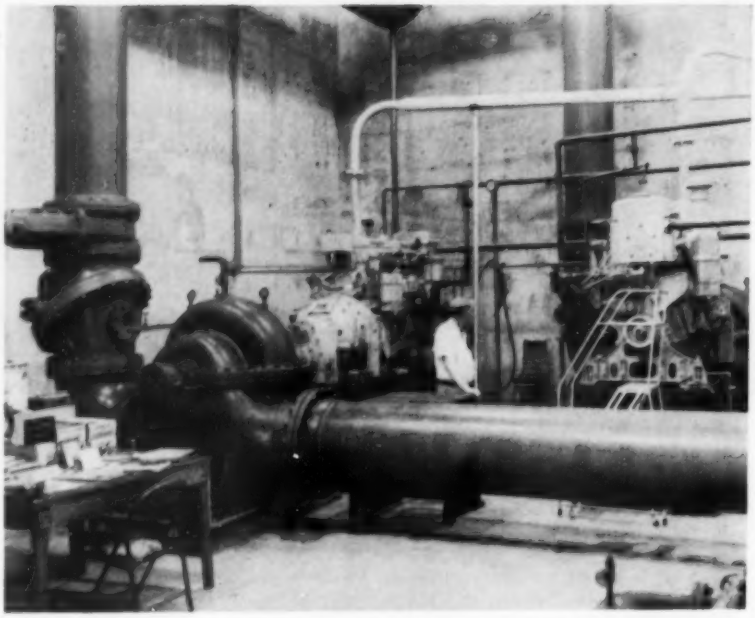


Fig. 9. The diesel-driven pumps below ground in the Chipola River pump house

Fig. 8. Pump house at the Chipola River

The Chipola River drains a watershed located mainly in northwestern Florida and southeastern Alabama. It is a tributary of the Appalachicola River which is a much larger stream draining, with tributaries, western Georgia and eastern Alabama. The river pump house is located on the south bank of the Chipola about two miles above its confluence with the Appalachicola. There is a cross connection between the Chipola and Appalachicola Rivers a few miles above the river pump house, and at times there is a flow from the second to the first. At that time the pumps get water in part from the Appalachicola River.

This location is sufficiently above tide water in the Appalachicola estuary to ensure year-round fresh water. Large bodies of water at closer points to the plant are saline, largely because they are a part of the Intracoastal Waterway, which parallels the Gulf Coast from Texas to central Florida and is subject to sea water tide flow through cross connections to the Gulf of Mexico.

With the river pump house located so close to the larger stream, water level in the Chipola River at this point is affected by variations in water level in the Appalachicola. One result of this interplay caused the only operational difficulty in the new canal in its four years of operation. A large dam at Chattahoochee on the Appalachicola was completed recently, and its reservoir was filled over a period of several months. Manipulation of water during this period, combined with low rainfall, failed to keep up the old river levels.

The effect of the low water levels in the Appalachicola during the late summer and autumn months of 1955 caused some tense moments at the St. Joe Paper plant. However, while unprecedently low, the water levels never fell below 2 ft 9 in. above the bell-mouthed intake elbows of the pumps, and the pump house remained operational.

Due to the large capacity of the canal as a reservoir, the paper mill would not have had to shut down for some time, even with the Chipola River pumps stopped.

The above storage capacity is expected to meet any emergency of relatively short duration. To date it has not been necessary to use it. Should there be any indication that the exceptional low water level in the Chipola during the 1955 dry season would become an annual problem, present plans call for some minor modifications at the Chipola River pump house which would permit continuous pumping with water level 2 ft 6 in. above sea level at the pump house. Army engineers have stated that the water will not be permitted to get below this point.

Engineers for the water supply canal project were Cummins & Barnard, Inc., of Ann Arbor, Michigan.

The inverted siphon at the Intracoastal Waterway, the crossing at Cypress Creek, together with related reinforced concrete structures, were laid or built by the Tidewater Construction Corp. of Norfolk, Virginia. Tidewater also built the two pump houses and installed the equipment.

Traveling water screens at both pump houses are Link-Belt (Model No. 45).

Centrifugal pumps at both pump houses are Gould pumps (Nos. 3080 and 3450).

Diesel engine drives at the river pump house are Caterpillar No. D-1300.

Electric motor drives at the river plant are by General Electric.

Cast iron pipe is by American Cast Iron Pipe Company; fluid couplings, by American Blower Company.

Excavation was by Woodlands Division of the St. Joe Paper Company.

T. S. Coldewey was in charge of whole project for St. Joe Paper Company.

H. H. Saunders was in charge of original mill operation.

**WOULD YOU LIKE TEAR SHEETS?**

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# Union Electric's 10,000,000 Mile Check-up

**Is your approach to maintenance up-to-date? Union Electric Company of Missouri keeps it that way with a five-point program**

WE ALL HATE to have our car break down and, somehow, it always picks the worst possible time to do it. To avoid trouble, most of us get in the habit of taking the old family bus in for check-up and repairs at regular intervals — the first thousand miles and maybe every five or ten thousand after that until we trade her in at 50, 60 — even 100,000 miles.

Power plants need check-ups, too, but their equipment is supposed to last a lot longer than a car. Power plant equipment runs day and night. At Union Electric, some of it's still going strong after 40 years of hard use. That's equivalent to 10,000,000 miles on your car. When you expect that kind of mileage, repairs and check-ups really are necessary.

Currently, the electric power industry is spending about $240,000,000 a year on plant maintenance — which is roughly one-fourth its total fuel bill. With that kind of money involved, it's obvious that good maintenance is vital to efficient operations.

At Union Electric, this problem has been met by a realistic and comprehensive maintenance program, developed over the years to keep costs down and efficiency up.

### Five Main Approaches

This program, as outlined in the company's magazine, has five main approaches: designing plants in the first place for easy maintenance, using machine accounting to pinpoint quickly just where the maintenance money goes, analyzing the record continually to improve maintenance methods, testing frequently for the first symptoms of possible breakdowns and providing training and information to assist and guide maintenance supervisors.

In designing power plants, there is a continuous effort by both designers and operators to produce new plants with improved economics in all phases of operation and maintenance. There are four main types of plant maintenance: breakdown, schedule, test and preventive.

Breakdown maintenance presupposes that maintenance work is done only after a failure has occurred. Nothing much is done to anticipate these difficulties or to head them off by inspection. This method works only on small items, unimportant motors and pumps and the like, where it is cheaper in the long run to replace the equipment.

Scheduled maintenance calls for the periodic inspection and repair of equipment at night, weekends or holidays, based on months of use, tonnage, etc. This can often head off serious trouble, but also can result in costly shutdowns when no actual maintenance is needed.

Test maintenance calls for regular high accuracy testing to indicate internal conditions. On a giant turbine generator, this requires equipping the machine at the time of purchase for highly accurate readings on temperatures, pressures, vibrations and other important data. On modern, high speed and high pressure units, these tests can show internal conditions almost like opening the casing.

Preventive maintenance is a misused term. It could mean periodic inspection and repair of equipment with the accent on *outage prevention* without much regard for any of the other vital factors. Union Electric has been following a program which could be considered a combination of all four methods.

If a turbine appears to be in good condition, it would appear uneconomical to shut the machine down for routine inspection or minor repairs. On the other hand, if it is determined by tests that vibration is increasing or operating efficiency deteriorating, the machine is shut down for detailed inspection and perhaps overhaul. The elimination of one three-week outage on a large generating unit can be worth $200,000 in operating costs.

### Cost Control

Cost control of the maintenance program has followed various methods. Considering that the company's repair bill runs about $3,000,000 a year, this control is important.

Records must be kept, of course, but just what kind is a problem, too. You don't want to add a high cost of keeping records on top of the normal maintenance costs. Systems which Union Electric has used have varied from a notebook in the foreman's pocket to elaborate accounting procedures.

The accounting system finally devised breaks down costs into some 200 separate maintenance accounts, tabulated monthly by business accounting machines on each major plant. Such records have permitted exhaustive analyses of cost trends and the results of efforts to improve maintenance methods.

In the final analysis, the problem is one of maintaining a balance between low maintenance costs on one side and maximum operating efficiency on the other. What it all adds up to at the end of the year in total operating costs is what really counts.

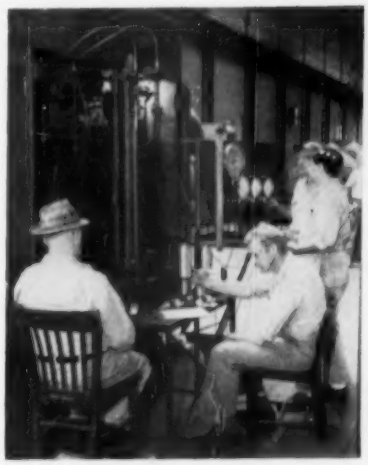
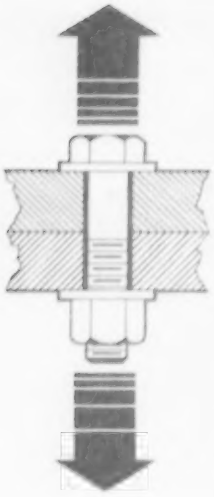


Fig. 1. Stethoscopic technique used on turbine generator determines maintenance needs without costly outage resulting from dismantling of equipment

Fig. 2. Checking turbine generator alignment can be done without the expense of removing casing or stopping machine. Modern methods make it easy

Fig. 3. Important cost saving can be achieved by using devices such as this speedy power buggy which rushes tools and materials straight to waiting job



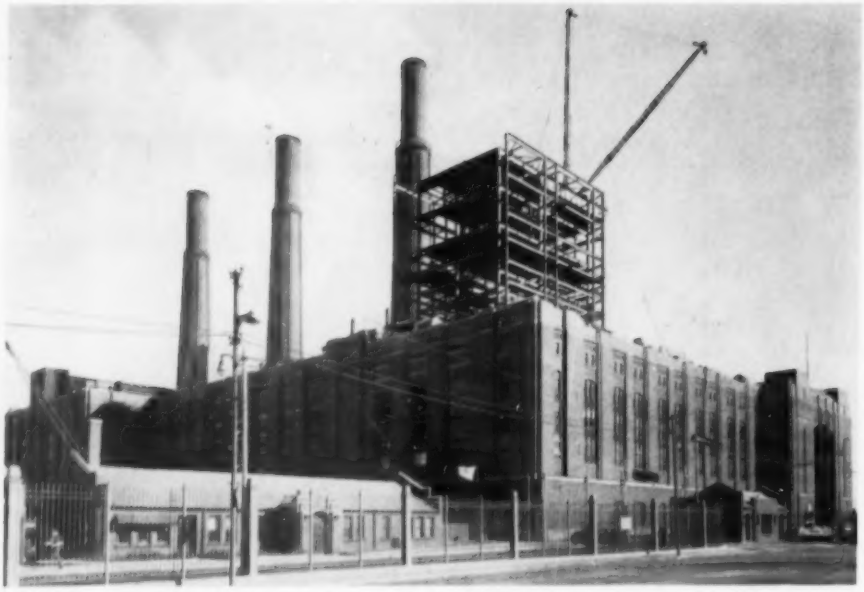


Fig. 1. High-strength bolts help build addition to Commonwealth's Crawford Station, Chicago

# HIGH-STRENGTH BOLTING . . .
## Ideal for Power Plant Structures

SOONER OR LATER practically all power plant operators face a construction problem when a new plant must be built, or an addition or alteration made to an existing structure: Shall the steelwork be welded, riveted, or bolted?

Welding and riveting are well-known construction methods, but high-strength bolting is a relative newcomer and its advantages not yet so generally appreciated in the field of power plant construction. An exception is Commonwealth Edison of Chicago, which has for some time erected practically all new steelwork with high-strength bolts.

To get a first-hand report on this technique as practiced by contractors for Commonwealth Edison, POWER ENGINEERING covered the erection of steelwork for a new boiler to be installed at Crawford Station (Fig. 1).

### What Is High-Strength Bolting?

High-strength bolts are used under much the same conditions as rivets, but offer certain advantages not obtainable with riveting. With correct tightening procedure, bolt tension clamps the members together so tightly that frictional force between them overcomes any shearing forces likely to be applied and thus prevents any tendency toward slippage. Similarly, bolt tension prevents any tendency of the members to separate; under these conditions, the bolt is unaffected by external stress or strain and thus is not subject to failure from fatigue.

Being stronger than rivets of the same diameter, the American Institute of Steel Construction permits high-strength bolts to be substituted for rivets. In shear, bolts increase the safety factor also. Tests have been reported in which two common bolts, two rivets, and two high-strength bolts were compared in their resistance to double shear; results are shown below:

| Type | Failure Point (lb) |
|---|---|
| Common bolts | 73,000 |
| Rivets | 90,200 |
| High-strength bolts | ———* |
| * Steel failed | 114,300 |

These figures indicate the high-strength bolted joint is stronger than a similar joint put together by riveting.

### Bolts Must Be Tight

When correctly tightened to specifications, high-strength bolts will not loosen from stretch, fatigue, or vibration, a characteristic not possessed by rivets. It is of interest that this structural technique was developed largely by railroad engineers who were plagued by the tendency of rivets to loosen under vibration in railway bridges.

Most important point in bolting is degree to which bolts are tightened. High-strength bolts, unlike common bolts, cannot be overtightened — that is, they will not stretch or become over-stressed short of actual breakage. As long as the bolt does not break under tightening, it will retain its clamping tension indefinitely.

High-strength bolts are readily identified by three radial dashes on the head, as shown in Fig. 2; heat treatment results in a black finish. No harm will be done if a common bolt is inadvertently substituted since it will break before required tension is reached.

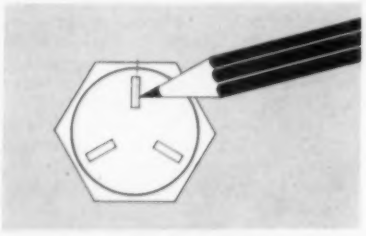


Fig. 2. Three radial dashes on head are standard marking of high-strength bolts

Fig. 3. First step in joining members is placement of temporary bolts; then alignment pins are driven in with air hammer to align the drilled bolt holes

Fig. 4. Next step is replacement of all the temporary bolts with high-strength bolts. These are drawn up tightly to hold members when pins are driven out

Fig. 5. Pins are replaced by remainder of high-strength bolts and all are gone over with impact wrench to make sure none have been overlooked in tightening

There are several approved methods of tightening bolts. When only a few bolts are to be installed, hand wrenching may be employed, utilizing a torque wrench to bring the bolts to recommended tension. Bolt supplier will furnish specifications. On bigger jobs, electric or air impact wrenches are used.

In such cases, the impact wrenches may be calibrated according to recommendations, or the "finger-tight plus one turn" method employed.

This latter method is that used in the steelwork shown here. E. J. Ruble, Engineering Division, American Association of Railroads, has demonstrated that high-strength bolts tightened in this way fall well within the tension specifications listed by bolt manufacturers. Since it requires about 2½ turns from the finger-tight position to break one of these bolts, a considerable safety factor exists even if a nut is run somewhat beyond one turn.

Procedure at the Crawford Station follows this pattern:

Steel members are raised into position by the erection crew and bolted with temporary erection bolts. Only enough of these bolts are installed to make the joint safe and to prevent overturning of the members. This frees the erection crew for other erection work. Later on the bolting crew of two men makes fine adjustment of member positions by driving in drift pins to align all holes. Enough additional erection bolts are then installed to pull joints together in preparation for high-strength bolting.

High-strength bolts are then installed by substituting them for the erection bolts, one at a time.

Drift pins are driven out by air hammer and high-strength bolts installed in their places. All of these high-strength bolts are run up finger-tight and then given one additional full turn.

A spot check is made from time to time by an inspector with a torque wrench.

High-strength bolting is fast, safe, and dependable, providing structures as strong or stronger than those put together with rivets. Although bolts are more expensive, savings are effected in labor costs. And, compared to riveting, bolting is practically noiseless, a boon in populated areas.

Fig. 6. Torque wrench used to spot check; standard method of bolt tightening on job is finger tight plus one full turn

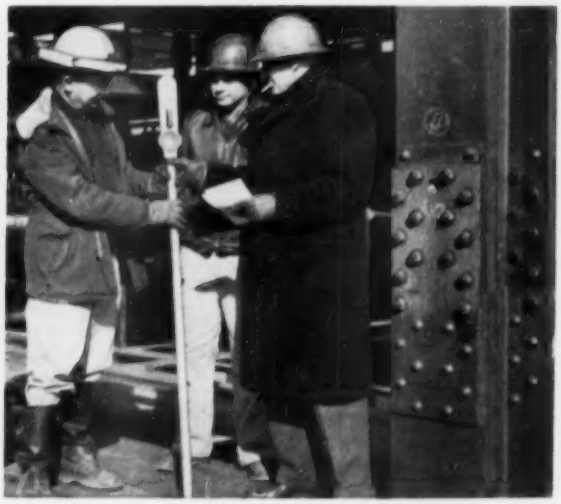
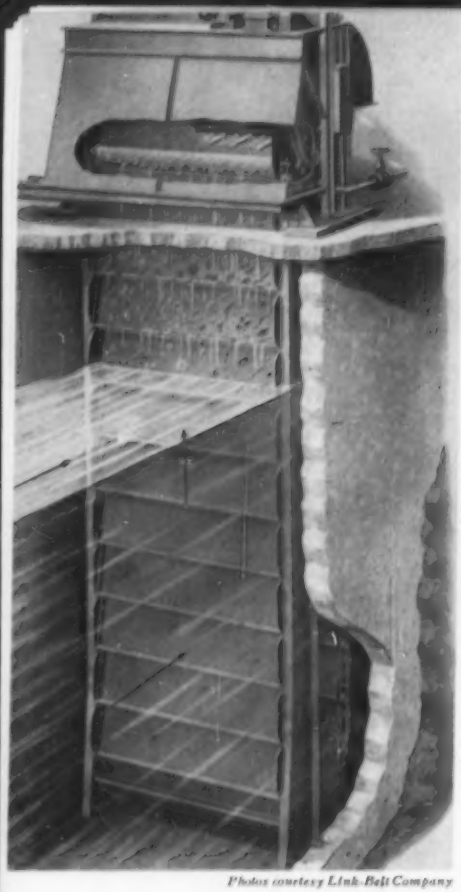


Fig. 7. Finished joint, right; with king-size torque wrench, Schaefer, Bowden of ComEd and Associate Editor Hagenmiller



*Photos courtesy Link-Belt Company*

Fig. 1. Typical traveling water screen installation; clearances are important

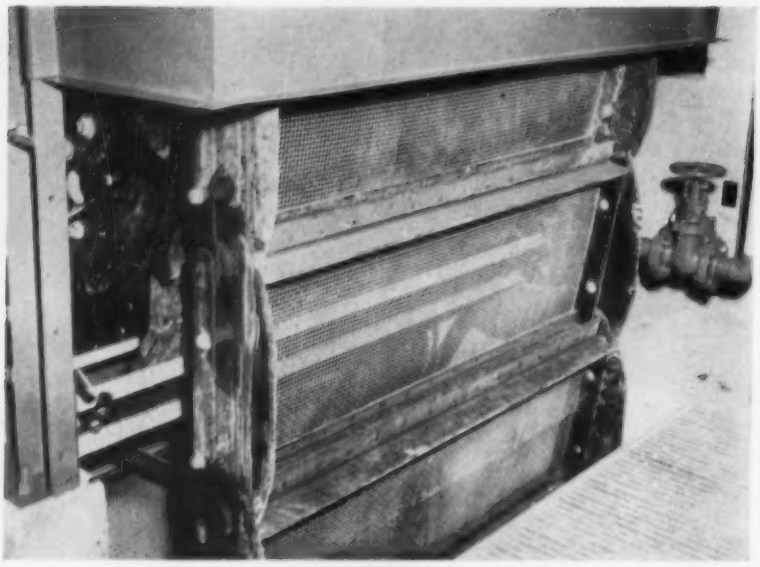


Fig. 2. Close-up view shows basket construction of traveling screen. To check clearance at base apron, secure strips of sheet lead to basket edges with screws

# Check Your Circulating

**Here are some easily-overlooked trouble spots to avoid before you start up the new plant. Circulating water systems may not appear to be complicated, but their failure can shut down your plant**

**By J. H. HUNNICUTT***

WHEN CHECKING OUT the plant's condenser circulating water system prior to initial operation, particular attention should be paid to the following items if the most common sources of operational difficulty within this part of the plant system are to be eliminated:

1. Correct alignment and positioning of traveling screens (Fig. 1).
2. Correct circulating water pump alignment, impeller clearance, and bearing lubrication (Fig. 3).
3. Cleanliness of intake well.
4. Agreement of condenser flow valve positions with indicators.

Under certain operating conditions, nothing can more promptly or effectively shut down a thermal generating station than an inadequate or malfunctioning system for screening marine life or debris from condenser circulating water. The author recalls a case in point involving a large station in New England:

This particular plant is located approximately two hundred miles inland on the banks of a large river from which it takes circulating water. The normal flow of the river is exceptionally clear of debris and save for a few winter months when tramp ice posed a problem, circulating water difficulties were unknown. Several years of operating experience had failed to record a single instance when marine life had interfered with plant operation. There simply was no marine life of any significance in this particular river. The design engineer had incorporated the conventional traveling screen in the plant, but for lack of adverse experience the operating people had not taken the installation seriously.

Inspection had been somewhat lax in this regard, and during the construction stages, an abnormally large gap had been left between the bottom of the traveling screen and the assembly base plate. A school of migratory eels making the first such run within memory found their way into the intake tunnel. An eel's head can plug only one condenser tube, but its body, mangled by the circulating water pumps, can account for 20 or 30 others.

The entire plant tripped out due to low vacuum and dumped a load of over 200,000 kw in five minutes.

Moral: Regardless of how unimportant or little-used *any* piece of plant equipment may appear, remember that it was incorporated in the design to perform one special function or to protect against one particular condition. Make sure that it is properly installed and maintained. Above all, understand its function.

Before the stop-logs are removed and the circulating water intake well flooded, the traveling screens should be carefully inspected for correct alignment and screen tension. If excessive play is allowed to remain in the screen itself, subsequent water swells may produce a whipping action which invariably shears the bolts positioning the screen foot shafts.

The shafts themselves are to be inspected to ascertain that they are perfectly horizontal and parallel. Finally, it should be determined that clearance between the bottom of the screen and the assembly base plate, while adequate to permit unobstructed travel, is not so great that it will permit the entry of any but the smallest debris or marine life (i.e., that which could normally pass through the screen mesh, yet be too small to plug tubes.

To check this clearance effectively,

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*Project Supt., The Kuljian Corp., Caracas, Venezuela.

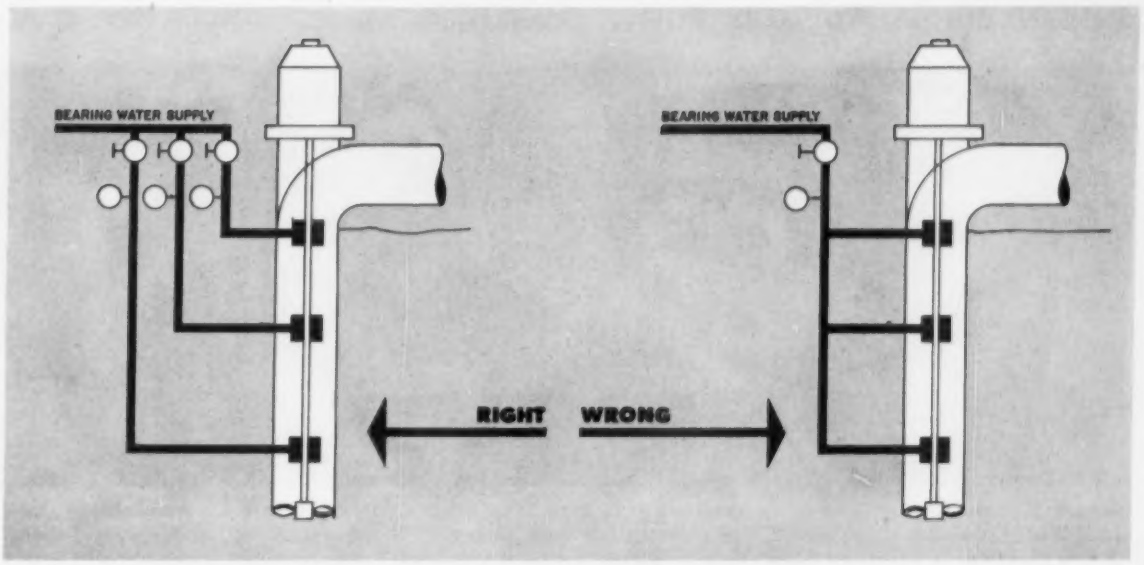



Fig. 3. Diagram shows right and wrong way to pipe water to rubberized pump bearings. Wrong way may permit over-supply to some bearings, starve others

# Water System Before Plant Start-Up

a simple test has been devised: Five or six proportionately spaced baskets in the screen are selected and their lower edges drilled and tapped. Small pieces of sheet lead approximately ¾-in. thick are then wrapped around the leading edges of these lower basket lips and securely attached (see Fig. 2). The screen is then run for a complete revolution of the assembly, after which these pieces of lead are inspected. Should they be mashed or flattened, the clearances are not adequate.

Clearance between the circulating pump impeller and the pump inlet bell should now be checked with feeler gauges, the impeller rotated one-half turn, and this clearance checked again. Different manufacturers specify varying ranges of clearance which can be tolerated in their particular pump and manufacturers' handbooks should be consulted in this regard.

The final operation before stoplogs are pulled and the intake well flooded is the thorough cleaning of the well itself. Particular attention should be paid to removing the blocks of wood and other floating trash which are invariably left behind by the construction crafts, and which could easily jam between the pump impeller and intake bell.

Various circulating water pump manufacturers have, within the past several years, resorted to the use of rubber insert bearings along the pump shaft, particularly on deep well pumps. These require water lubrication and where the water pumped is salty or has sand entrainment, however slight, an external source of clean fresh water is required for this lubrication. The pressure of this externally supplied water to the bearings must also be sufficient to overcome the pressure of the water within the pump chamber in order to exclude the contaminated water from the inner surfaces of the bearing inserts.

The author has observed that the piping arrangement for this type of bearing lubricating water is frequently left to the discretion of construction forces in the field and, often as not, is so arranged that one of the shaft bearings receives the major portion of the water supplied and the others "starve"; bearing failure is a not infrequent result. Figure 3 illustrates the desirable and undesirable arrangements. Bearing water supply should be manifolded with individual water lines, each with its own valve and pressure gage, to all bearings.

Finally, the condenser should be inspected from the water boxes. Flow regulating valves, where installed, should be manipulated through their complete travel and note taken that all positions agree with that shown on the position indicators mounted outside the condenser. Sacrificial anodes, if used, and any other water box attachments should be carefully checked for secure mounting so there will be no chance of their coming adrift when the unit goes into operation. The condenser should then be closed up and made ready for operation.

Circulating water pumps may now be started, the water boxes vented, and the unit observed for leaks. After these have been corrected and each circulating water pump run-in for the recommended period of time, the circulating water system may be considered ready for operation.

**FIFTH of a group of articles, all related to initial operation of the new power plant, this section describes some of the precautions necessary to avoid trouble in the circulating water system.**

**The author is expert in start-up procedures; it has been his principal job for many years.**

**Among future articles to appear in POWER ENGINEERING on this subject are the following:**

- Cleaning of Auxiliary Piping
- Inspection, Cleaning, Testing Tanks
- Instrumentation and Controls
- The Boiler (in four parts)
- The Turbine (in three parts)
- Preliminary Operation

**Both the author and your editors welcome your comments and suggestions on this series of articles as they appear.**

THESE NAMES HELPED MAKE POWER CONFERENCE NEWS

**Donald S. Kennedy** of Oklahoma Gas & Electric, president of Edison Electric Institute, estimated 6,700,000 kw of generating capacity installed this year

**Walter Henry Zinn** (l.) received Certificate of Merit for contributions to peacetime nuclear power. John T. Rettaliata president of I.I.T. gave plaque

**Hon. Fred G. Aandahl,** Assistant Secretary of Interior, warned that power industry must be prepared against weapons more powerful than A-bombs

# American Power Conference Sees Great

HOLDING its 19th annual meeting at Hotel Sherman in Chicago, March 27 to 29, the American Power Conference (which began as the Midwest Power Conference) brought together over 3000 of the country's leading power engineers to discuss their present problems and the power possibilities of the future. This conference attracts national and world-wide attention because it is the only one devoted entirely to the problems of the power engineer. The intense activity and interest in this rapidly expanding field of the power engineer was demonstrated by the fact that every session of this conference was crowded to the doors.

Comments on outstanding technical papers are given below. All papers will be published complete in a bound volume of proceedings, a copy of which will be sent to each Conference registrant. Director of the Conference is R. A. Budenholzer and Conference Secretary is E. R. Whitehead, both of Illinois Institute of Technology, Technology Center, Chicago, Ill.

### General Sessions

At the opening session, John Jirgal, chairman of the group on Power Generation and Distribution, Second Hoover Commission, discussed Incorporation of Existing Federal Power Projects.

W. H. Zinn, president of General Nuclear Engineering Corp, and one of the pioneers in that field, was presented by John T. Rettaliata, president of IIT, with a certificate of merit for his outstanding contributions to the development of peacetime nuclear power.

Dr. Zinn then addressed the conference, as summarized later in this report. He was followed by Dr. Norman H. Hillberry, who discussed the future of nuclear power; his address is also summarized later.

Donald S. Kennedy, president of Edison Electric Institute, told the APC luncheon meeting that investment in privately-financed electric utility companies is expected to gain an average of more than $4 billion a year over the next decade. Reviewing the development of the industry over the last 50 years, he said its output has grown from less than 6 billion kwh to over 600 billion kwh. This growth is attributable to the industry's consistent planning for the future. He concluded by discussing the differences in conception and operation between the investor-owned and the publicly-owned utilities.

Principal speaker at the All Engineers Dinner was Gwilym A. Price, president of Westinghouse Electric Co. Emphasizing the importance of research to the power industry, he said that electrical manufacturers, either for their own or for contract projects, are spending about 6 per cent of their sales income on research and development, second highest amount among all industries. Much of this research is being carried on as a partnership between electrical manufacturers and utilities. It raises productivity of men and efficiency of power-making machines. It has yielded products giving new life to the industry and will lead to still greater developments. And it must be increased if we are to move ahead.

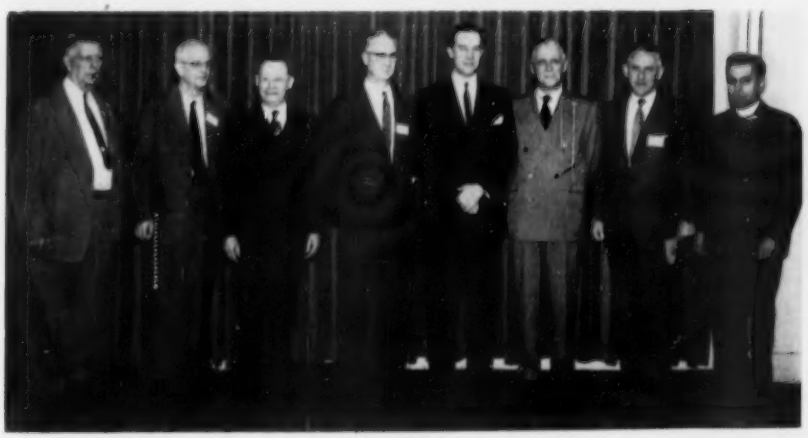
Fred G. Aandahl, Assistant Secretary of the Interior, addressed a luncheon meeting on the Electric Utility Industry in Civil Defense, while Gordon M. Freeman of IBEW spoke to another luncheon meeting on Why Labor Supports Our Free Enterprise System. Trends in Employment Conditions for Engineers were discussed by six prominent engineers in a symposium, to be reported later.

### Industrial Power

Industrial applications for combined gas-turbine-steam turbine plants were analyzed by W. B. Wilson of G-E. He reviewed first the performance of a combined plant in which a 5000-kw gas turbine burning natural gas exhausts to a waste-heat supplementary-fired boiler generating 120,000 lb per hr of 250 psig steam, which drives a steam turbine extracting to process. Fuel chargeable to power is 30 per cent less than for a 600-psig, 750 F steam turbine plant.

Mr. Wilson then gave details of boilers to utilize gas turbine exhaust, such as pressure drop in exhaust and variations in exhaust flow and temperature. The gas turbine can also be used to supercharge a boiler. The speaker then reviewed points in the performance of combined plants for

**THESE MEN OPENED THE MEETING**



W. A. Lewis, I.I.T., co-chairman; Norman Hilberry, Argonne National Laboratory; John Jirgal, 2nd Hoover Commission; W. H. Zinn, General Nuclear Engineering Corp.; J. T. Rettaliata, I.I.T., Allen Van Wyck, president Illinois Power Co., and chairman; Donald S. Kennedy, president Edison Electric Institute; Rev. Iver G. Lawrence, I.I.T. chaplain

# Power Field Future

**Guiding light:** R. A. Budenholzer of I.I.T., Conference Director

both generator and mechanical drive.

Costing of steam and electric power in an industrial plant, H. P. Kallen of *Power* pointed out, has been approached in various ways. A costing method satisfactory to one company may not fit the needs of another. Results of energy-distribution costing are used by engineers and management to show how possible improvements may be made, hence they should reflect actual plant conditions.

To indicate the factors involved, two hypothetical systems were detailed by the speaker: System A, non-condensing generation of electric power in parallel with a pressure-reducing valve, with no steam bled for process; System B, condensing generation of power in parallel with non-condensing generation, at two pressure levels and with process steam used at two pressure levels and a reducing valve. Calculating available energy balances, the speaker showed, for System A, a charge to the process of 0.692 Btu per Btu supplied, while for the enthalpy drop method the charge was 1 Btu. For electric power, 3,413 Btu per kwh based on enthalpy drop and 10,840 Btu per kwh based on available energy drop.

For system B, based on enthalpy drop, charges are: electric power 6520 Btu per kwh; mechanical power 2545 Btu per hphr, process I, 0.985 Btu per Btu supplied; process II, 0.985 Btu per Btu supplied. Based on available energy drop, charges are: electric power, 11,220 Btu per kwh, mechan-

## Quotable Quotes from Speakers at American Power Conference

The forecast for total utility sales in 1970 is 1486 billion kwh, and conventional fuel burning plants will account for the bulk of electrical generating capacity installed by 1970.
— *D. R. Wilson, Babcock & Wilcox Co*

1957 will see the first commercial movement of coal over long distance by pipe line.
— *Clarence A. Dauber, Cleveland Electric Illuminating Co*

In the foreseeable future, the steam turbine will continue to be the work-horse for generating electric power.
— *C. D. Wilson, Allis-Chalmers Mfg. Co*

The pay-off for new break-throughs to steam conditions higher than base becomes large only some 10 to 12 years after establishment of the base.
— *C. W. Elson and J. E. Downs, General Electric Co*

Estimated as equivalent to 23 billion kwh in 1953, the world's energy consumption can be expected to triple this figure by 1975 and increase eight-fold by the year 2000.
— *R. C. Jordan, University of Minnesota*

Predictions are that the bituminous coal market will expand to a total of 480 million tons consumption by 1961.
— *George A. Lamb, Pittsburgh Consolidation Coal Co*

The rate of growth in (utilities) investment now is three billion dollars per year and is expected to average over four billion a year over the next ten years.
— *Donald S. Kennedy, president, Edison Electric Institute*

In 1957, the United States will spend about $6.3 billion on industrial research and development. . . . Electrical manufacturers . . . are spending about 6 per cent of their sales income for those programs.
— *Gwilym A. Price, president, Westinghouse Electric Co*

Emergence of the high-speed pump is undeniably the most important development that has taken place in the field of boiler feeding in the last 20 years — first from 1800 to 3600 rpm in the middle 1930's and now, barely 20 years later, the magic number corresponding to the synchronous speed of a two-pole electric motor has lost its inviolability.

Can we therefore look forward to passing beyond the present self-imposed limit of 9000 rpm?
*I. J. Karassik and T. W. Edwards, Worthington Corp*

Based on over-all industry statistics, the use of electric power has increased from 5.5 kwh per man hour of industrial worker in 1947 to 10.2 kwh per industrial worker in 1956, and is expected to be over 20 kwh by 1966.
*M. M. Patterson, E. V. Pollard, and W. B. Wilson, General Electric Co*

## MEETING THE EXPERTS . . .

**A varied program of specialized group sessions made it possible for engineers to hear experts in many fields**

**Steam Turbines:** C. D. Wilson, chief turbine design engineer for Allis-Chalmers, reviewed recent advances in the design of large steam turbines

**Industrial Power:** Gerald L. Decker, Dow Chemical Co.; H. P. Kallen, Power; F. G. Feeley, Jr., Olin Mathieson Chemical Corp., chairman; W. B. Wilson, GE; A. D. Brooks, Dow Chemical; C. R. Earle, POWER ENGINEERING, co-chairman

ical power 11,860 Btu per hphr; process I, 0.685 Btu per Btu supplied; process II, 0.316 Btu per Btu supplied.

M. M. Patterson, E. V. Pollard and W. B. Wilson, all of G-E, gave data on economics of higher pressures and temperatures for steam turbines in industrial plants. They gave curves and data on effects on costs resulting from higher steam conditions, fuel chargeable to power, extraction steam, effect of process steam pressure, and effect of feedwater heating. Cost comparisons showed that taking 1450 psig 950 F as a base, fuel costs were 67 per cent greater for a 600-psig 750 F plant. For same initial steam, 3 stages of feedwater heating saved 30.2 and 19.9 per cent respectively compared with no feedwater stage heating.

Annual fuel savings ranged from $145,000, for 600 psig 750 F, 3 stages of feedwater heating, to $379,000 for 1450 psig 950, 3 stages of feedwater heating. These are for a plant supplying 25,000 kw net, 175,000 lb per hr of 150 psig and 175,000 lb per hr of 50 psig process steam and fuel cost of 30 cents per million Btu.

They pointed out that estimated installed generating capacity in industrial plants had risen 30 per cent from 12.8 million kw in 1946 to 17.2 million kw in 1956.

One of the first installations to demonstrate to the utility industry (next after the Belle Isle installation) the possibilities of using the combined gas and steam cycle was described by A. R. Le Bailly and L. Skog, Jr of Sargent & Lundy. This is the Rio Pecos plant of West Texas Utilities Co.

This was an existing plant of three 6000-kw 250 psig steam turbine generators, with multiple boilers, installed in 1926 and a 5000-kw simple cycle gas turbine installed in 1954. More capacity was needed and the authors showed how a 33,000-kw, 850-psig steam turbine generator and a 300,000-lb-per-hr pressurized boiler were added. Details of the heat balance and methods of combining operation of the various units to meet the conditions are given. Result is to increase combined efficiency 7.4 per cent over the conventional 4-heater cycle, lower overall plant investment, permit independent operation of gas or steam turbine, have high reliability.

If you are operating non-condensing turbine generators in your plant, how many kilowatts are you losing due to valve throttling in the turbine valves? Gerald L. Decker of the Dow Chemical Co explained how his company found they were losing 2000 to 3000 kw because of throttling where turbine valves were only cracked open. In some of their turbines, decreases in efficiency of 6 per cent were found. The author explained how they conducted incremental efficiency tests to determine how the performance of the turbines varied at various valve openings compared with the smooth efficiency curve usually used. As a result, valve position indicators were developed for guiding the operator in operating the turbine with full valve opening.

Following this, Aaron D. Brooks of Dow explained how precise loading of turbines at selected valve points is determined by a digital computer. This gives more power per pound of steam than would result if the same turbines were loaded at incremental steam rates, as is usual.

Savings in loading four topping turbines at Dow's Midland plant at selected valve points instead of equal incremental rates averages a conservative 1000 kw. This is equivalent to a net annual saving of over $52,000 in purchased power.

For comparable steam conditions, said E. L. Daman of Foster Wheeler and E. L. Richardson of G-E, a gas turbine supercharged boiler and steam

**Hydroelectric Power:** Robert A. Monroe, chief design engineer, TVA; Walter Dreyer, v.p. Pacific Gas & Electric; chairman Adolph J. Ackerman; G. W. Breuker, I.I.T. student

**Fuels:** co-chairman John Blair; Clarence A. Dauber, Cleveland Electric; chairman Martin A. Elliott, I.I.T.; W. S. Landers, U. S. Bureau of Mines; George Lamb, Pittsburgh Consolidation Coal

**Employment Conditions:** G. Brooks Earnest, president Fenn College, Cleveland, and six others took part in panel

**Water Technology:** M. D. Baker, West Penn Power Co.; T. J. Hodan, Allis-Chalmers; N. L. Dickinson and E. A. Pirsh, Babcock & Wilcox; Robert T. Hess and Warren A. Greten, Conn. Light & Power; chairman S. F. Whirl, Duquesne Light

turbine plant shows heat rates substantially better than those possible with the reheat cycle and with investment comparable to that for the conventional non-reheat cycle. Based on a 45,000-kw plant (smaller ones down to 25,000 are practical) the supercharged plant costs only $15,700 more than a conventional plant and, with No. 6 oil fuel, has a plant heat rate 7.4 per cent lower than that of a conventional plant. For supercharged boiler details, see POWER ENGINEERING, January 1956.

To reduce boiler exit losses and thus increase efficiency in the new Eddystone 5000-psi, 1200-F installation, Samuel M. Arnow of Philadelphia Electric explained details of the method used for incorporating heat from the stack gases into the supercritical turbine heat cycle. This is done by the method shown in Fig. 4, page 59, January 1957 POWER ENGINEERING. Calculations show this should result in a reduction of about 100 Btu per net kwh in the heat rate, equivalent to about 1¼ per cent increase in the thermal efficiency.

### Computers Used

Several new and interesting uses of the new computers and calculating devices in power engineering were described, as applied to mechanical as contrasted with electrical problems. Use of a computer for analyzing turbine valve points at Dow has already been mentioned. Use of digital computers for piping flexibility calculations was explained by Tor Kolflat and K. E. Knapp of Sargent & Lundy. Generalized heat balance computation on the IBM type 650, was detailed by J. E. Gerngross of G-E and R. K. Large of Detroit Edison. Using a building block approach, this method can be programmed in a few days, many computations of different heat balance details can be performed quickly and accurately, and many days of laborious hand calculations eliminated.

Use of the new computers and their effects on all phases of electric system operation permeated all the electrical sessions of the conference. These will be reviewed in a separate article.

### Water Technology

Four sessions on water technology were held for standing-room-only audiences. Varon of Richfield Oil, Los Angeles, and Applebaum of Cochrane Corp, Philadelphia, presented a joint paper on the successful application of hot lime zeolite treatment to moderately-high pressure boiler operations at Richfield's Watson Refinery. Harden and Hull of Indiana Standard's Whiting Refinery discussed their experiences with a large hot lime zeolite system for 1500-psi boilers operating at 100 per cent make-up. The two-year-old system, they report, has provided better quality water at less cost than the previous hot lime soda phosphate plant.

L. Wirth, Jr, National Aluminate Corp, Chicago, surveyed a number of operating hot lime zeolite plants, pointed out problems at each and how they were solved. Resin replacement, he said, should be considered as a normal part of process operating costs.

Hydrazine received the usual attention and vigorous discussion. Dickinson, Felgar, and Pirsh, Babcock and Wilcox, reported an experimental investigation of hydrazine-oxygen reaction rates in boiler feedwater and presented an equation fitting their observed data. Those contemplating use of hydrazine will find valuable information in this paper.

Hess and Greten of Connecticut Light and Power contributed a discussion of their experiences in using a hydrazine-sodium sulphite combination. (See POWER ENGINEERING, September 1955.) With one boiler, said the authors, the combination treatment reduced sulphite requirements 93 per cent.

Reviewing three years of operation with hydrazine, Baker of West Penn Power indicated his belief that although hydrazine is a satisfactory oxygen scavenger in systems without 100 per cent deaeration, it is not the final answer and the search must continue.

Making accurate measurements of oxygen in feedwater is a problem which appears to have been solved by development of an instrument which provides continuous, auto-

**Extra High Voltage:** T. B. Gross, I.I.T.; F. A. Lane, American Gas & Electric; F. J. Lane, England; chairman Philip Sporn, American Gas & Electric; Gunnar Jancke, Sweden; E. C. Starr, Bonneville Power

**Electric Systems:** E. C. Glass, Northern States Power Co.; R. H. Travers, Ohio Edison; L. B. LeVesconte, Sargent & Lundy; C. P. Almon, Jr., TVA; M. S. Helm, U. of Ill.; Nathan Cohn, L&N

## THE LIGHTER SIDE . . .

POWER ENGINEERING's hospitality suite was a center of lively interest and activity throughout the conference. Here is Associate Editor Ray C. Hagenmiller presiding at a drawing of attendance prize tickets. Prizes were given to visitors each day

Maxine Hagenmiller with POWER ENGINEERING's grand prize, a repeating shotgun, won by E. L. C. Larson of Otter Tail Power Co., Fergus Falls, Minn.

R. H. Morris (right), Editorial Director of POWER ENGINEERING with a prize winner on night of All Engineers dinner

K. C. Molzahn (r) of Wisconsin Public Service Co., Green Bay, visits with POWER ENGINEERING's A. W. Kramer

matic recordings of dissolved oxygen concentration. Greene and Negus of Arnold O. Beckman, Inc, described the analyzer developed by that company and stated that it had sufficient speed of response to make it useful for detecting oxygen leakage into feedwater systems.

Demineralizer operation was covered by a practical paper from Duff and Dvorin of Graver Water Conditioning which demonstrated how methods of reducing rinse requirements could lower operating costs.

### Condensers and Pumps

Aluminum condenser tubes have been installed in the Oak Creek plant of Wisconsin Electric Power Co, and W. A. Pollock of that company presented a paper on their experience with the installation to date. As Wilson, consulting engineer with Allis-Chalmers, pointed out in a prepared discussion, this operation will be followed with interest by the utility industry for the next few years. Ellis Verink, Jr, of Alcoa, also submitted prepared discussion of the Pollock paper and gave significant comparative cost data on aluminum vs Admiralty tubes. On a "capitalized cost" basis, Verink gave figures to show that if aluminum tubes last 8 years, Admiralty tubes can never break even on such a basis.

Two papers were given on the subject of welding non-ferrous tubes in heat exchangers. Wilson and Edens of Allis-Chalmers described their success with steam surface condensers, and George Worn, consultant to The Lummus Co, reported on feedwater heaters.

An interesting progress report on the high-speed boiler feed pump was presented by Karassik and Edwards of Worthington Corp. Future of this type of pump, the authors believe, is assured as pressure and temperatures go up.

### Steam Turbines

Characteristic types and typical arrangements of turbine generator units were described from slides, by C. D. Wilson, chief turbine design engineer for Allis-Chalmers.

Wilson pointed out that turbine builders are being constantly asked by the power industry to provide machines that are simple in design, so that they can be easily and quickly dismantled for servicing.

As a noteworthy recent step in this direction Wilson presented the new 250-mw cross-compound machine now being built for the Oak Creek Station of the Wisconsin Electric Power Co. This machine is designed for 2400-psig, 1050 F inlet steam, 1000 F reheat and ½-in. of mercury absolute exhaust pressure.

Considerable simplification has been achieved on this machine by locating the turbine operating floor at the centerline of the unit. This has eliminated all stairways and railings and all the removable aprons that formerly had to be dismantled when servicing the turbine. It has made space available below the operating floor and above the turbine foundation for much of the turbine auxiliary piping and for some of the extraction piping, which formerly had to go down inside the foundation, or else required trenches or sleeves through the foundation.

Wilson explained that this same principle of locating the operating floor at the centerline of the unit can be applied to 3600-rpm tandem machines and to 3600/3600-rpm cross-compound machines.

C. W. Elston and J. E. Downs, both of General Electric's large steam turbine-generator department, presented a paper on the future of the steam turbine cycle.

Studies were described which show that the payoff for new breakthroughs to steam conditions higher than base become large only some 10 to 12 years after establishment of the base. This means that the realization by the industry of large savings from advances in steam conditions beyond 4500 psig, 1150/1050/1000 F (Philo Plant of the Ohio Power Co.) will not come until the 1970's.

To what extent atomic energy will

E. W. Corner of the Grinnel Co., and D. B. Bramley of the Worthington Corp.

J. R. Morrissey, U. S. Navy, and W. L. Eckdahl of Republic Flow Meters Co.

H. E. Stites, Central Ill. Public Service Co., and W. S. Bloor, Leeds & Northrup

**IN THE CORRIDORS . . .**

F. M. Swengal, Wm. A. Pope Co., and N. D. Barnett, Commonwealth Edison

A. K. Howell, Jr., Howell Eng. Equipment Co., and R. E. Doerr of Monsanto Co.

M. D. Baker, West Penn Power Co., and H. O. Bennett of Standard Oil Company

affect the potential savings of conventional fuels, and thereby affect the incentive for higher steam conditions is not clear at this time. But it is believed that nuclear power will first become economically attractive in the large ratings and in areas of high costs for conventional fuels. These situations are among the ones providing the greatest incentive for higher steam conditions with fossil fuels.

Of particular interest is the combined steam and gas cycle. However, such a cycle must be suitable for coal burning if it is to have large economic significance when applied to conventional-fuel burning plants. At present, Elston and Downs stated, considerable development will be required before the resulting products of combustion can be passed through a gas turbine.

Also studied have been binary cycles which use steam in the high-temperature region and freon in the low-temperature end of the cycle. These studies indicate that the penalty of the temperature difference in the steam-to-freon heat transfer apparatus overcomes other efficiency gains and that for comparable overall cycle efficiencies it is more expensive than the normal steam cycle.

Currently being explored are some multiple reheat steam cycles with very high pressures, but with moderate initial temperature. Investigation is also going forward on the use of a very high, second reheat steam temperature using gas turbine design practices in the steam turbine. Here a substantial heat rate improvement is sought at a moderate cost increase.

Elston and Downs encouraged work with new cycles and new arrangements of equipment as a significant contribution in the search for alternate means to reduce power costs.

Their conclusion: At the present time, it appears that the capital cost of the next immediate step in steam conditions is several times the worth of fuel savings.

### Large Steam Generators

D. R. Wilson, assistant chief engineer of the Babcock & Wilcox Co. boiler division, outlined advances in the field of large steam generators. The most important advance, he said, is the design and development of supercritical steam generators.

Wilson first described the unit installed in 1955 in the Burlington Station of the Public Service Electric and Gas Co.

This is the highest pressure steam generating unit in service today, and is designed for a pressure of 2700 psi, delivers 1,225,000 lb of steam per hour at 2390 psi and 1100 F with reheat to 1050 F, and serves a 200,000-kw turbine. See POWER ENGINEERING, June, 1956.

Wilson also described the first supercritical pressure boiler for power generation in this country — the unit being installed at the Philo Plant. This unit will deliver 675,000 lb of steam per hour at a pressure of 4500 psi and a temperature of 1150 F to a 125 mw turbine. The steam will be reheated twice — to 1050 F and 1000 F.

The trend into the supercritical pressure range dictates the "once-through" design of steam generator since there is no density differential between steam and water for natural or controlled circulation. In a once-through steam generator the solids in the feedwater must either deposit out in the tubes or leave with the steam. Therefore, a high degree of feedwater purity is required and condenser leakage or other conditions contributing to feedwater impurities cannot be tolerated.

Wilson explained that the control of once-through boilers is simpler than that of subcritical pressure units because one point of control, the drum water level, is eliminated. The steam pressure controls the feedwater flow, while the firing rate is controlled to maintain final steam temperature.

Wilson reported that designs for much higher capacity units have been developed, and mentioned a cyclone furnace unit scheduled for installation at the Breed Plant of the Indiana & Michigan Electric Co. This unit will deliver 2,900,000 lb of steam per hour at 3500 psi and 1050 F with two stages of reheat to 1050 F *continued on page 106*

*This is the first of three articles by the author discussing the problems relating to the installation of spare boiler feed pumps in modern high-pressure power plants. The cost of modern spare equipment is so high and the reliability of equipment is such that designers are reducing and even seriously considering eliminating spare pumps*

# How Much Spare B-F Pump Capacity Do You Need?

By IGOR J. KARASSIK*

COST OF building steam power plants has been increasing in recent years. This increase reflects both the higher material and labor costs and the growing severity of operating conditions. As a result, the attention of power plant designers has been directed towards various departures from existing practices which might yield substantial savings without necessarily affecting the reliability of the equipment or the availability of the entire plant.

One of the departures which is beginning to be given serious consideration is the possibility of reducing the number of spare pumps in a multiple-unit steam plant, if not of eliminating them entirely. It is with the considerations which need enter into such a decision that we shall deal here. The subject matter is not entirely new to power plant designers or operators, but it merits discussion in this group of articles which is intended to cover the variety of operating problems which confront the steam power plant operator in connection with his high pressure boiler feed pumps.

A short 20 or 25 years ago, no power plant operator dared to consider running a plant without a steam turbine driven standby boiler feed pump to protect him against the possible interruption of electric power supply. This turbine driven standby pump was frequently installed in addition to a motor driven spare.

### Operation Without Spares????

We must admit that such a superabundance of spare equipment was not solely dictated by considerations of motive power availability. It reflected a well merited scepticism of the reliability of the high-pressure pumps themselves.

Several independent factors were responsible for the gradual reduction in spare equipment which took place during the following decades. On one hand, the ability to interrupt the firing of the boilers much more quickly eliminated some of the hazards resulting from premature and unexpected boiler feed pump failures. Alternate sources of electric power supply increased the dependability of motor drive. Finally, improvements in pump design, materials and construction technique have reduced the frequency of required overhauls and unexpected pump shutdowns.

Still, the complete elimination of the spare pumping equipment remains a very controversial subject. This controversial characteristic stems from two sources: the lack of sufficient statistical experience to predict accurately an availability figure for boiler feed pumps operating under widely different conditions and the inability of the power plant designers to assign a tangible dollar sign to the potential interruption of service through unavailability of boiler feedwater.

It becomes obvious that the decision to eliminate the spare pump or not, must for the time being be reached on a somewhat subjective basis; in other words, it must reflect the individual designer's estimate of the reliability of the equipment he has selected for his power plant. But the very word *reliability* is possessed with very intangible characteristics.

I have frequently tried to define it, but never have I succeeded in improving a definition I once read in the advertisement of a firm manufacturing components for electronic computers: "The reliability of a particular component or system of components, is the probability that it will do what it is supposed to do under operating conditions for a specified operating time."

### Reliability—What Is It?

This definition illustrates how difficult it must be to assign a significant number to the reliability of a boiler feed pump. To calculate or predict a probability it is necessary to carry out statistical research with a number of units much higher than is available for such research.

To define *operating conditions*, it is not sufficient to list required capacities and pressures prevailing temperatures and probable variations in the value of these three items. It is also

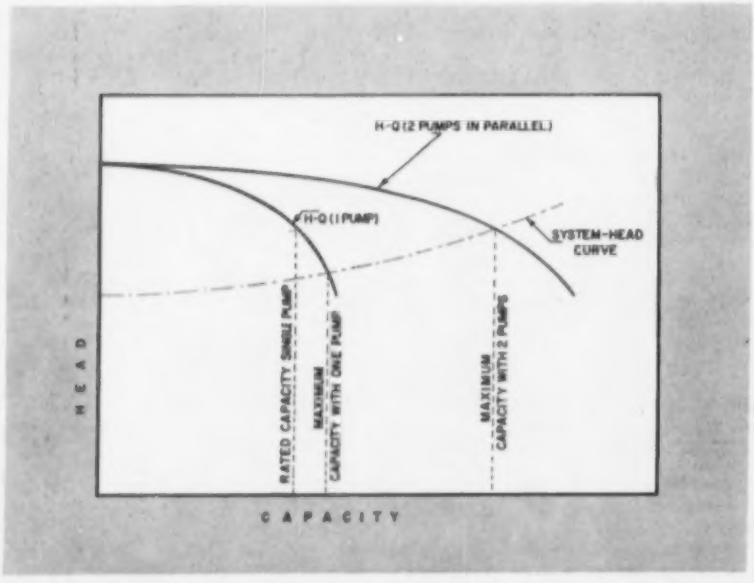



Fig. 1. Analysis of maximum flows when one or two half-capacity pumps are used

*Assistant to Vice-President and Consulting Engineer, Harrison Div. Worthington Corp.

necessary to predict any and all possible other factors and *events* which may intervene with the ability of the pump to "do what it is supposed to do."

To expand on this thought, let us consider the possible interruptions of service due to circumstances beyond the control of the pump manufacturer, in other words due to causes other than errors in design, application or execution. It is true that the intrinsic reliability of the modern boiler feed pump is such that one can expect from 60,000 to 120,000 hrs of operation between overhauls. There are, however, a number of operating hazards which confront the boiler feed pump which have no equivalent counterpart in the case of the boiler or turbine generator.

Perhaps the most important of these hazards is the possibility of foreign matter (such as mill scale or brittle oxides), being introduced into the pump. Statistically, this hazard ranks very high on the list of pump failures reported by utilities.

Another serious hazard is introduced by transient operating conditions in an open feed system, when sudden reductions in main turbine load result in too rapid a reduction in heater pressure and in the flashing and steam-binding of the boiler feed pump.

All these hazards must be taken into consideration when the possibility of eliminating a spare pump is evaluated. But they cannot be given the same weight for every installation.

For instance, there are two solutions to the problem of selecting the number of boiler feed pumps required to feed the boiler under full load conditions. The choice between these solutions is not within the scope of the present article. Suffice it to say that for units up to 300,000 kw, the choice lies between the use of two so-called half-capacity pumps or one full-capacity pump. The effect of this choice upon a decision on spare pump capacity is quite obvious.

### Full Capacity vs Half Capacity

If a single full-capacity pump is installed to serve a given unit, any unscheduled outage of the pump or of its driver means the shutdown of the main unit unless a spare pump is installed. On the other hand, if two-half-capacity pumps are installed, the shutdown of one of these will merely reduce the load which can be carried by the turbine generator to something between 55 and 65 per cent of rated load, depending on the selected pump capacity margin at full load and on the shape of the system-head curve. This effect is illustrated by the accompanying curves.

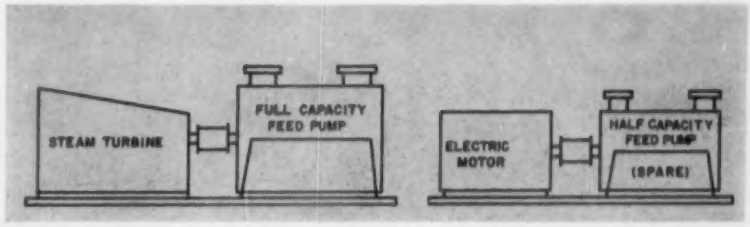



Fig. 2. If you have a single full-capacity pump, can you eliminate the spare?

It follows that operating hazards can be discounted to a greater degree for an installation which includes half-capacity pumps and that greater justification exists to eliminate the spare boiler feed pump in such installations. On the other hand, eliminating the spare pump in a one-pump installation introduces a certain element of risk which can only be justified in the event that the main unit represents a reasonably small percentage of the total system capability and can therefore be withdrawn from the system without disturbing it unduly.

In such a case, the only penalty for the interruption caused by a boiler feed pump outage is the higher cost of electrical production in the less efficient standby steam power plant which must replace the lost capability. There is, of course, an additional intangible penalty in the frayed nerves of operators and manufacturer alike during the time it takes to restore the boiler feed pump to service.

### Relative Costs

Some power plant designers may wish to go further than just estimate an intangible possibility of power interruption. While this article does not pretend to provide a completely detailed method for a rigorous calculation of the cost of power interruption, it may be interesting to give a very rough idea of the logic employed in arriving at some quantitative figures.

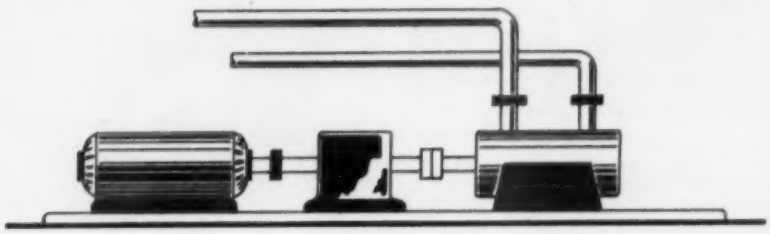
Suppose that a new unit of 200,000 kw is to be installed and that consideration is being given to providing it with a single full-capacity steam turbine driven boiler feed pump with no spare. It is estimated that installing a second duplicate steam turbine driven pump will cost approximately $400,000 including the pump, its driver, piping and controls. Assuming capitalization at 12 per cent, the elimination of the spare pump represents a yearly saving of $50,000.

On the other hand, interruption of service from this newest unit in the system would entail its replacement with several less efficient units which would have a heat rate approximately 3000 Btu per kwh higher than the new 200,000-kw unit. Assuming a cost of 30 cents per million Btus, this means that an interruption lasting 278 hr would eat up the entire yearly savings indicated above.

Obviously these figures are approximately typical and will vary considerably between different systems. But it remains still to make a guess as to whether our single full-capacity boiler feed pump can be expected to accumulate an average unscheduled outage of 278 hr per yr from all causes.

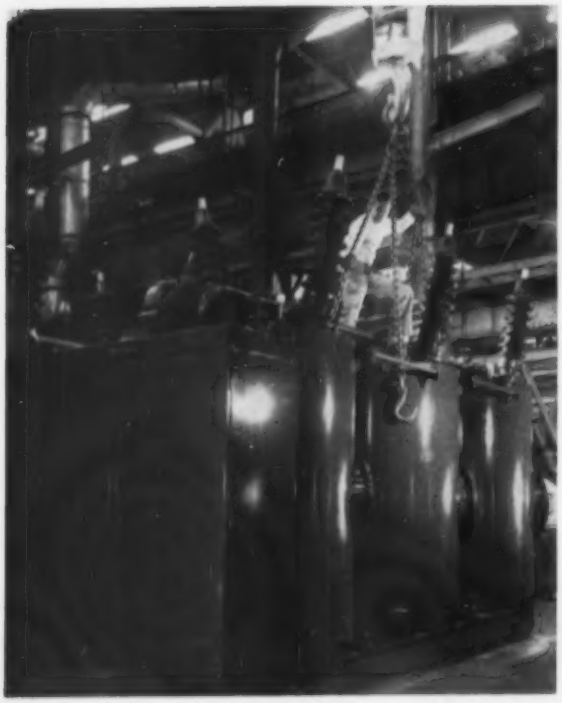
It goes without saying that the decision to eliminate the spare boiler feed pump should have a definite bearing on the spare part inventory carried by the power plant. When spare pumps are available, the practice varies. In some cases, a stock of renewable parts such as wearing rings, bushings, balancing devices, sleeves and bearing parts is considered sufficient while other power plants prefer to include a complete inner assembly as well. If no spare pump is installed, a complete inner assembly should always be included so as to reduce necessary outage time in case of an emergency to a minimum.

In the next article we shall examine certain special cases in which factors other than reliability considerations enter into the decision whether to provide spare boiler feed pumps or not, to meet certain requirements.

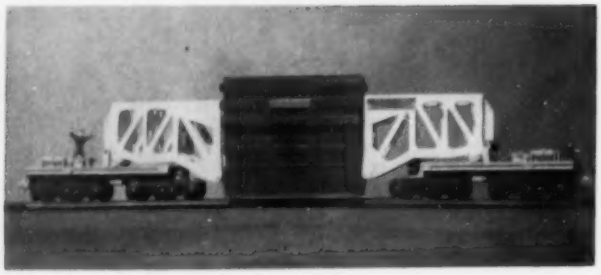


**Test pit for turbine generator rotors** is part of new facility at Allis-Chalmers for simulating actual running conditions. In this view, 98-ton rotor for 300-mw turbine generator is being lowered into bearings for overspeed test and precision balancing. Massively constructed of steel and reinforced concrete, pit is 50-ft long, 11-ft wide and 18-ft deep with a 9-ft thick shock-absorbent breech-block cover. A 2500-hp motor drives rotors through an eddy-current coupler

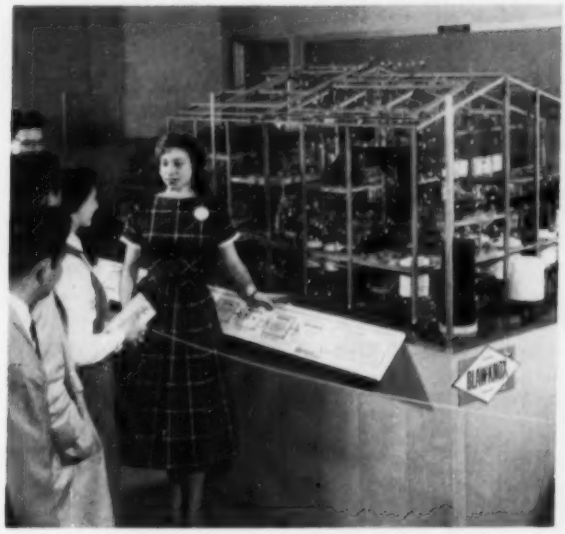
# POWER ENGINEERING'S



**First of its rating ever built,** this 5,000,000-kva, 69-kv tubular-grid oil circuit breaker was recently shipped by Westinghouse Electric to Florida Power and Light Co. Twenty-six more of these will be delivered in 1957 and 1958



**Transformers going places** . . . Above, model of unique rail car designed by Westinghouse to ship large units. On outbound trip, transformer is part of car; on return, ends are joined together. Below: Mobile 7500-kva GE transformer, ready for emergency anywhere, serves Mississippi P&L system

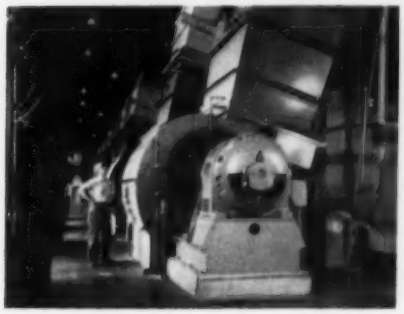


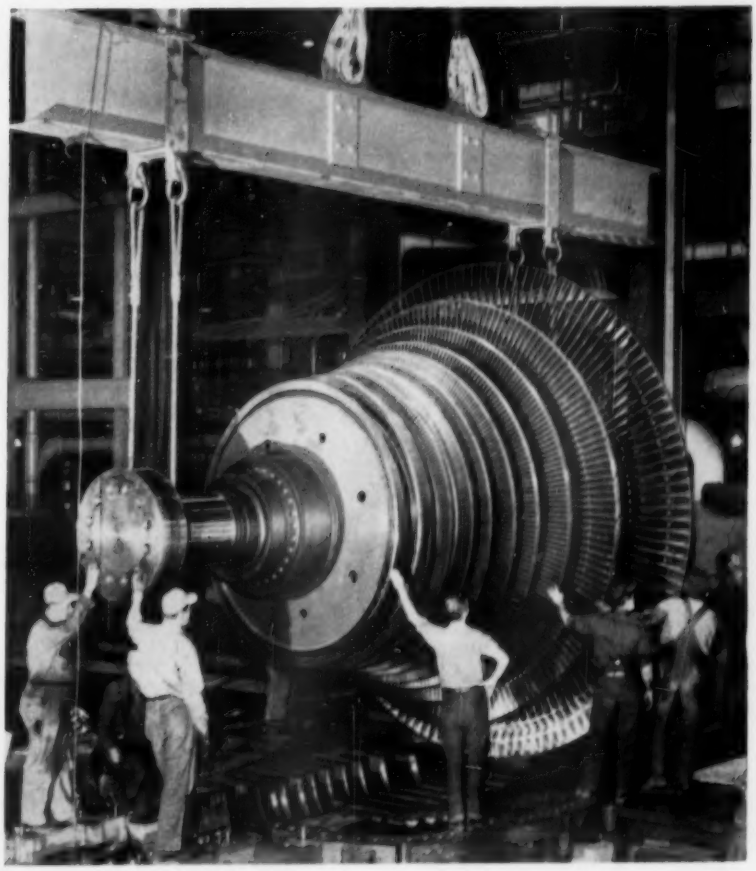
**Younger generation faces atomic age,** and interest in future was expressed at University of Pittsburgh during Engineering Week. Here, students see how nuclear fuel is produced; model shows plant designed by Blaw-Knox for AEC

**Watching for trouble** in a hazardous area is aided by closed circuit TV set at Esso's Bayway plant in New Jersey. Shift foreman, in remote location, can observe danger spot with General Precision Lab set, take necessary action fast

# NEWS REEL

**Large induction motors,** like those shown above and below, move air, pump liquids, drive machines; do you know their stall, starting characteristics? See POWER ENGINEERING'S April issue





**Big wheel at Commonwealth Edison** . . . Part of a 260,000-kw generating unit being installed at ComEd's new Will County station near Lemont, Ill.; rotating speed at tip of longest rotor blades will be faster than speed of sound

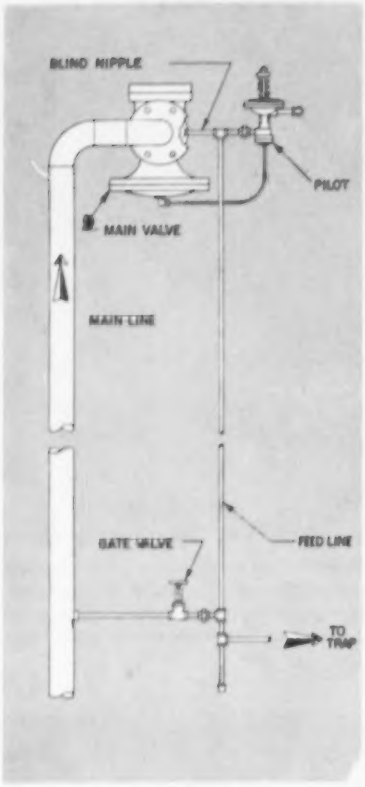



Fig. 1. Simplest control for on-and-off

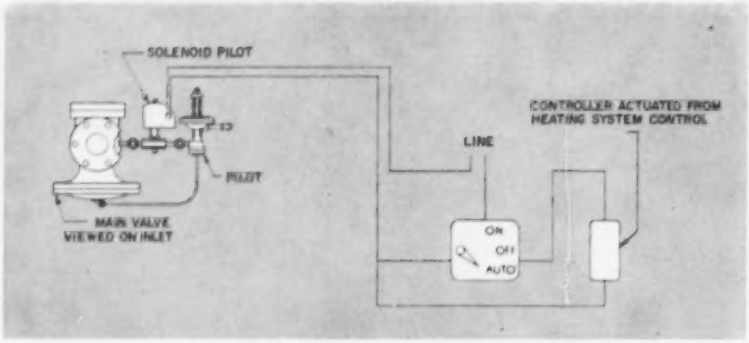



Fig. 2. Solenoid controlled from heating system control causes pilot to operate

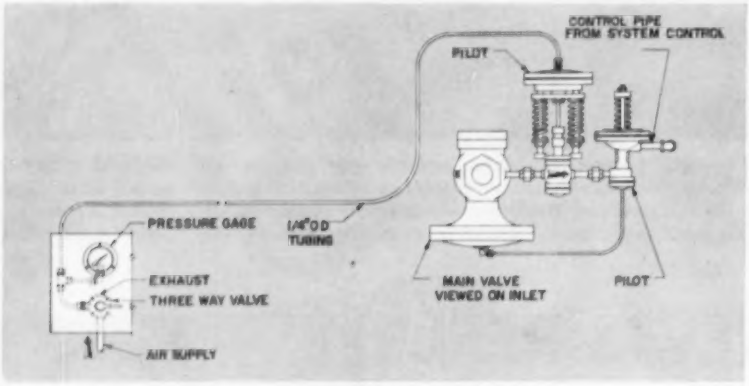



Fig. 3. Auxiliary pilot valve can give remote control when connected in this way

# Remote Controls for a Self-Powered Pressure Regulator

**Here are some tips on such control systems for pilot-operated self-powered regulators. Power engineers supplying steam and other fluids for processes, heating, air conditioning, find these remote controls systems applicable to various operating conditions**

POWER ENGINEERS in industry are frequently called on to solve problems of supplying steam, water or other fluids to processes. In hotels, hospitals, state institutions and the like, there are many problems in supplying steam, or hot and cold water for heating, air-conditioning systems, kitchens, and so on.

Steam pressures must be maintained by pressure regulating valves and the power engineer is often faced with the job of devising new or revised automatic control systems for these valves. This article shows ideas for working out some of these systems.

Need for them may come about through a change in manufacturing process; perhaps operating cost or product loss must be reduced. Expanded facilities may require additional controls. In general, where fluid flow is to be controlled, simple self-operated regulating valves, requiring no separate source of power, are usually considered first; and in many, if not most cases, they fit the need.

Remote control of some sort may frequently be desirable — perhaps to lessen operator fatigue or save his time for other duties. In other instances, remote control may be implicit in the system by the size or mechanics of the process being controlled. In one case, the benefits of remote control might be sacrificed because of the expected cost. In another, such control might be achieved at greater expense than is necessary, when actually the cost could frequently be nominal.

For instance, if a batch process requires periodic interruption of steam flow and the steam is fed to the unit through a pressure regulator, the simplest on-off control is by a hand valve in the steam main. Motor-operated and pneumatically-operated or hydraulically-operated gate and globe valves are also available that can be operated by the flick of a switch or a handle and can be mounted remotely from the operator.

But now let us assume that we wish to establish remote control for a steam pressure regulator with a separate pilot valve of the general type shown in the accompanying drawings. For simple, periodic on-and-off control, an arrangement like that of Fig. 1 can be used to advantage.

The pressure pilot of the regulator in Fig. 1 must be fed steam from the regulator's high side before the main valve will be opened. If this pilot

supply is piped through a small hand valve at the operating station, the operator can shut off the steam flow by shutting off the steam to the pilot. This arrangement permits greater freedom in locating the main piping and requires less maintenance and less effort from the operator than were the steam controlled by a hand valve in the main. It is also less expensive than a separate motorized valve in the main, both as to first cost and maintenance.

### Remote Control Tied In

Figures 2 and 3 illustrate extensions of the same principle. While these are valid for application to control at considerably greater distances, they are more applicable when the control of steam flow is to be tied to a more elaborate control system. A heating system, for instance, frequently consists of several zones fed through pressure regulators and controlled by a thermostatic system that employs air, hydraulic or electric power. Rather than separate large zone control valves, use of a second pressure or solenoid operated pilot will reduce first cost as well as maintenance.

### For Fast Pick-up

In some processes, a fast pick-up might require a higher pressure while a lower pressure is sufficient for holding. Figure 4 illustrates how two pressure pilots and one shut-off pilot, used as in the foregoing examples, can provide such control. When the solenoid pilot is closed, the pilot with the lower setting controls. When the solenoid pilot opens, the pilot with the higher setting would override the other, causing the regulator to function at the higher setting. The solenoid pilot could be operated through a manual switch or by a timing device.

### Pilot at Operating Station

Other operations or processes require more discriminating control at the discretion of an operator and his observation of feed rate, raw material condition, or other process variables. Remote control, within limits, can be accomplished by locating the pilot at the operating station while locating the main valve as is convenient to the piping. Figure 5 shows how this is done in the case of a pressure regulator by merely extending the normal connections over the distance required.

Where adjustment of this sort is needed at a still greater distance from the main valve, an arrangement like that in Fig. 6 may be used. Here again the pilot is mounted at the main valve but is of a different sort. The adjusting spring has been supplanted by a loading pressure confined under a hood over the pilot diaphragm and supplied through a small pressure reducing valve. The loading fluid may be the same as that passing through the regulator or may come from another source.

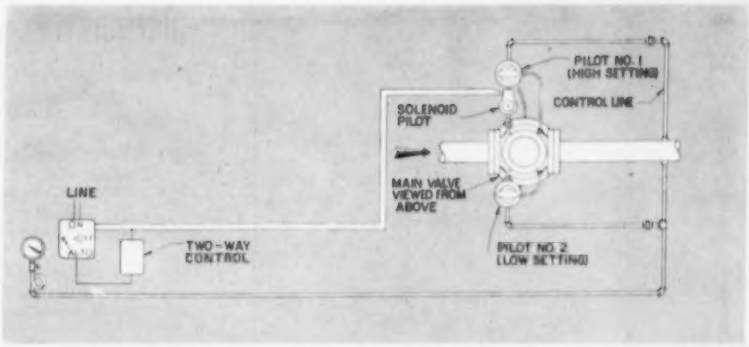



Fig. 4. For fast pick-up, high-setting pilot takes over when solenoid operates

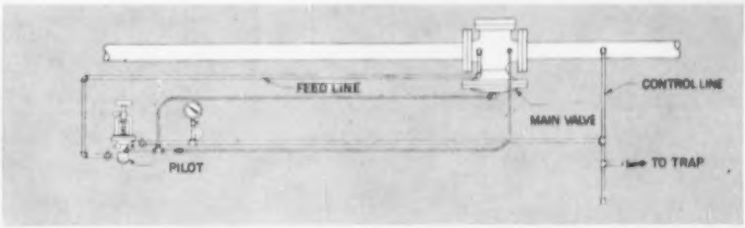



Fig. 5. With pilot at operating station, operator obtains close process control

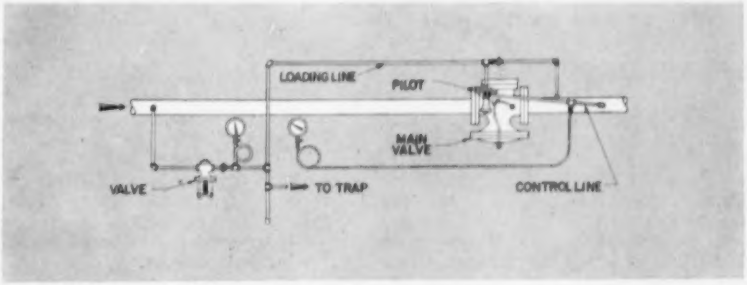



Fig. 6. For close control, load main valve pilot from smaller, remote regulator

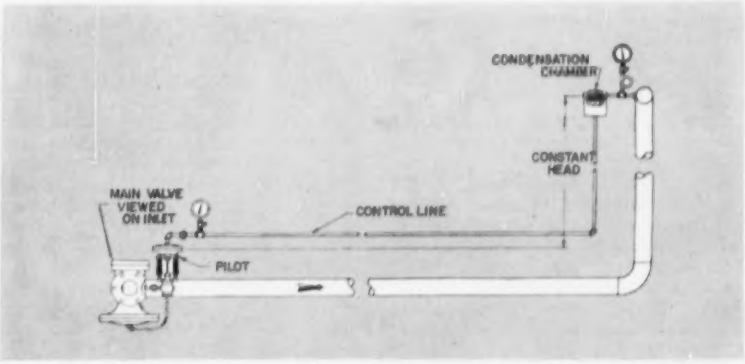



Fig. 7. To compensate for friction loss on long main, control pilot from ends

Different sort of remote control is illustrated in Fig. 7. Normal friction pressure-loss in piping sometimes results in inadequate pressures being maintained at the ends of long distribution mains. By extending the control pipe and making the ends of the mains the control points, a constant pressure at these points is assured.

All these hook-ups, according to the application engineers of Spence Engineering Co., Inc., are standard and inexpensive variations on the pilot-operated, self-powered regulating valve.

Fig. 1. Outside of Plant A, showing new radial brick stack (left), old one at right

**WHAT WILL IT COST?** What is right? How should we proceed? These are always basic questions when the crying need for modernization finally faces the power plant engineer. In finding right answers, it helps to know what has been the experience of other power plants which have grappled with the same problems. Here are answers from real life. With this article—the Case of Plant A—we present the first of six studies in methods and costs of modernizing industrial power plants of total steam capacities of 25,000 to 50,000 lb per hr. These facts and figures come out of the long experience of H. D. Fisher, for many years chief engineer of New Haven Box Board Co and now associated with Westcott & Mapes, Inc., consulting engineers of New Haven, Conn. He has often contributed to POWER ENGINEERING

# What It Costs to Modernize

**By H. D. FISHER**

THIS ARTICLE, first of a new series, is a supplement and enlargement of one by the same author published in the June 1953 issue of POWER ENGINEERING, titled Economical Ways to Modernize Small Industrial Power Plants. This briefly described three plants, labeled A, B and C. Data on three other plants, which had not been completed at that time, also cost figures which were not then available, on all six plants, will be included in the present series of articles. Plant symbols A, B and C, used in this series, refer to the same subjects treated in the 1953 article.

The original article discussed, at some length, changes in the setup of industrial power plants since the early 1900's, and their causes. Briefly, the most important of these changes have been the very widespread replacement of prime movers in the industrial power plant by purchased electrical power, and, in many localities (and particularly in the smaller plants) the substitution of oil for coal as fuel. Use of dump gas from the natural gas pipe line systems is probably ephemeral.

Circumstances causing each individual plant to assume its final form are described in these present articles. In the main, these reasons fall into the following classifications:

(a) Disrating of boilers due to age, wear-and-tear and obsolescence.

(b) Outgrowing of power-generating facilities originally installed, due to enlargements of plants, increasing mechanization of factory processes, and greater power consumption per unit of output and per employee.

(c) Continued reduction in price of purchased power as contrasted with the rise in cost of self-generated power due to rise in wages for attendance of prime movers and cost of fuel. These increases, together with the present-day level of power plant equipment costs, make even by-product power a questionable venture except in very large installations. In the smaller installations, cost of attendance of prime movers would alone pay a substantial fraction of the power bill.

(d) Reduction in steaming capacity required where only heating and process steam are needed.

Principles which were followed in the planning of the installations described in this article and the ones to follow aimed at obtaining dependable service, long life and low maintenance costs at a moderate initial expenditure. These principles were as follows:

(1) Consistency of design, good quality without frills; no one dressed in a frock coat and top hat, but rather with bare feet. As an ideal, to have the plant wear out like the one-hoss shay.

(2) Careful determination of steam requirements; adequate capacity without expensive oversizing.

(3) Utilization of existing buildings wherever feasible.

(4) Selection of equipment which will fit into the layout of existing foundations, flues and piping with a minimum of changes.

(5) Purchase of high quality equipment for and to manufacturers' standards, without calling for special features that add to cost without corresponding benefit.

Now a word from the writer to his fellow sufferers, project engineers or whatever their titles are, who have to make estimates for projects and then see them carried out within the budget:

On most of the projects to be analyzed in these articles, the writer succeeded, with the aid of his good angel and plenty of hard work, and it is hoped that the cost figures given here will assist others, either as a check on overall totals, or on specific items such as piping, plans for which are rather hazy in the early stages of a project, yet the owner insists on having some sort of estimate to help decide whether to proceed or not.

Years in which the contracts were let appear at the head of the cost tabulations on the various projects and much of the data can be brought up-to-date by applying price indexes such as those of Marshall & Stevens, which appear in engineering magazines dealing with construction in various fields. To make up-dating easier, the principal items are described in reasonable detail and can be further evaluated from the photographs, so that the user can determine how closely they correspond to his own problem.

These cost figures, applying only to boiler plants, and rather small ones at that, do not serve so well for the approach of Fearnside and Chemy of Stone & Webster Engineering Corp. in their ASME paper 52-A-108, Industrial Power Plant Construction Costs Since World War II, in which

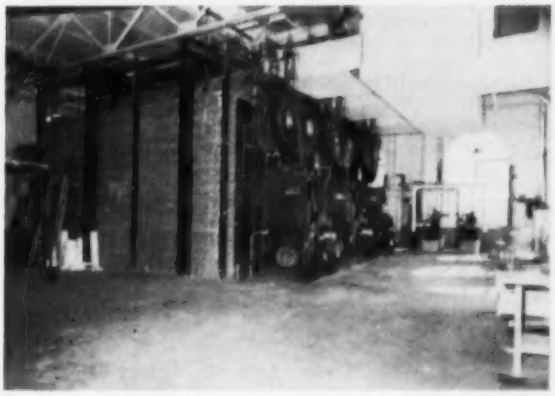
## COST OF MODERNIZING PLANT A – 1951

| | | |
|---|---|---|
| Boilers & settings—three 78" x 18' welded hrt boilers, ASME Code fo. 125 lb pressure with feedwater regulators, soot blowers, erected on owner's foundations | Bigelow Co. | $ 25,270 |
| Solid refractory settings | W. G. Meade & Son | 19,721 |
| Flue—⅛" inside building, ⅜" outside | Bigelow Co. | 5411 |
| Support for deaerator and walk | Bigelow Co. | 2841 |
| Oil burners installation | Peabody Engineering Co. | 19,055 |
| Deaerating feedwater heater, 36,000 lb per hr, 20 min storage | Cochrane Corp. through Turbine Equipment Co. | 4052 |
| Two duplex boiler feed pumps, 7½ x 5 x 10 with drip pans, lubricators & pump governors | Warren Steam Pump Co. | 2009 |
| Radial brick chimney 6'–0" top dia x 125' high with lightning rod | Custodis Construction Co. | 11,831 |
| Chimney foundation 48 cu yd concrete 64 cu yd excavating | Kelley Wood Co. | 2456 |
| Building alterations and foundation work | C. F. Wooding & Co. | 7317 |
| Piping | Foskett and Bishop Co. | 17,477 |
| Insulation | Cummings Insulation Co. | |
| Piping | | 1984 |
| Flue | | 1385 |
| Deaerator | | 443 |
| Emergency generator, 30 kw | U. S. Electric Co. through Connecticut Electric Equipment & Co. | 2840 |
| Electric wiring | L. W. Reynolds | 989 |
| Engineering | Westcott & Mapes, Inc. | 13,380 |
| Wrecking old boilers and chimney | Connecticut Demolition Co. | 1800 |

Estimated cost ....$143,994 Actual Cost....$140,261

Cost per lb per hr normal steaming capacity $3.88

# Small Industrial Power Plants



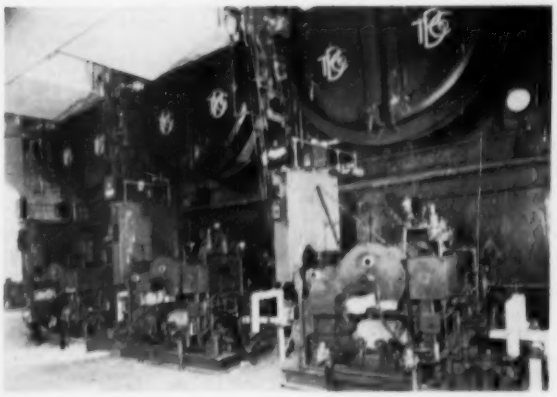


Fig. 2. Space in the boiler room was limited, so to provide room for a possible fourth boiler, the three new boilers were set in one battery. They are 84-in. hrt units with 3-in. 18 ft tubes, cost $25,270 in '51

Fig. 3 (right, above). Close-up of oil burners. Units selected are automatic, forced draft, pressure atomizing. Cost was $19,055 in '51. Note special flue design (upper left) necessitated by problem of head room

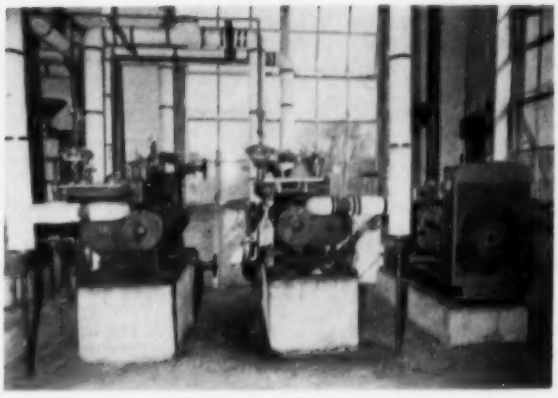


Fig. 4. This view shows the new boiler feed pumps and emergency generator. Cost was $4849 in '51. A new deaerating feedwater heater was installed over these pumps and above the level of the building's roof trusses

the cost of minor items is related to that of the major items of the project, such as boiler, turbine generator and condenser; so that by obtaining prices on these large items and multiplying by the proper factor, the total cost may be arrived at quickly.

Another somewhat more useful approach would be similar to that described in ASME paper 52-A-109 by J. Campbell, senior power engineer of E. I. DuPont de Nemours & Co, in which the various items of cost are expressed as percentages of the total cost of the project. The writer has not done this with his own costs because all the examples do not contain corresponding items. In some, existing buildings were used; in others stacks, piping or fuel storage were available with little expense for alteration.

A third plan, offered by C. S. Robinson, assistant principal power engineer of E. I. DuPont de Nemours & Co. in ASME paper 52-A-107, Economical Industrial Power Plant Design, compares costs of various projects on the basis of dollars per pound per hour of steaming capacity, and, if due allowance is made for equipment quality required by steam pressure and temperature, this is probably the most accurate basis of comparison of costs.

### The Case of Plant A

The original boiler installation in this manufacturing plant, which makes small metal specialties, was made in the early 1900's. It consisted of six 72-in. horizontal return tubular boilers with 18-ft tubes, and supplied steam to drive a steam engine and direct-current generator, and for process work. As usual, plant expansion outgrew engine capacity and purchase of alternating current power from the local utility began. Purchased power rates came down, coal prices and wages rose and in the 1930's the engine was discontinued and everything changed over to purchased power.

During one of the slumps in price of fuel oil the boilers were equipped with flat-flame oil burners and a 20,000-gal underground tank was installed adjacent to the boiler house.

In 1950 it was evident that the boiler settings required very extensive repairs, the boiler insurance company was warning that the age of the boilers made them increasingly undesirable risks, and factory expansion provided a desirable use for the boiler house for a production department. So it was decided to replace the boilers.

The former engine room, from which most of the equipment had been removed, provided a suitable location for the new boilers, particularly as it stood somewhat isolated from the main factory group of buildings and was of little use except for dead storage of odds and ends; also, the old engine foundations provided an excellent base for the boilers.

From monthly fuel oil consumption figures and Weather Bureau records, it was decided that a steaming capacity of 24,000 lb per hour with a 4-hour overload capacity of 27,000 lb per hour should be adequate (as it has proved to be). To meet this demand three 84-in hrt boilers with 3-in. 18-ft tubes and solid refractory settings were installed (one a spare) equipped with automatic, forced draft, pressure atomizing oil burners.

The space in the former engine room was rather limited; so, to provide room for a possible future fourth boiler, the three boilers were set in one battery. Head room above the old engine foundations and under the roof trusses was such that a rather special flue design was necessary, as can be seen from Fig. 2. Figure 3 shows a closeup of the burner installation, and Fig. 4 shows the boiler feed pumps and emergency generator. Figure 1 is an outside view of the converted engine room and new radial brick stack, the old boiler house and its stack appearing at the right. A new deaerating feedwater heater was installed at the end of the building over the boiler feed pumps and above level of roof trusses.

The existing fuel oil tank was adequate and continued in use, new suction and return lines being installed in a concrete-lined trench.

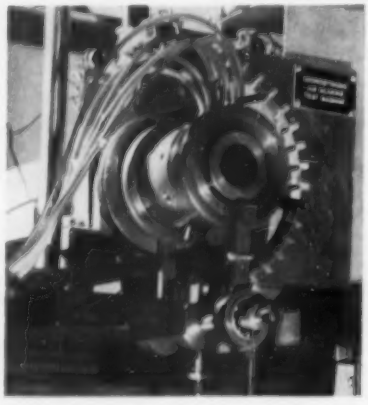
Exhaust steam from the boiler feed pumps is used for feed water heating supplemented by live steam supplied through a reducing valve. An oil separator was installed in the feed pump exhaust steam line and a Blackburn grease filter in the feed water line to the boilers. Drips from the fuel oil heaters are piped to waste.

Next article will describe how Plant B was modernized, all the details being different from Plant A.

## Air, Molten Metals, Glass, May Be Bearing Lubricants of Future

ONE ENGINEERING authority recently predicted that new concepts in bearings and lubricants would lead to the breakthrough needed to meet the demands of the Space Age.

Dr. Robert O. Fehr of the General Electric Co's General Engineering Laboratory said the challenge of fantastically high speeds and high temperatures of the ultramodern era calls for a drastic revision of engineering principles.



Such revolutionary concepts as air bearings, which greatly minimize friction, and the use of molten metals and molten glass as supersonic lubricants are being studied, he said.

Fehr, manager of mechanical engineering for the laboratory, made the statements at the opening of the company's new million-dollar Bearing and Lubricant Center, the largest test and development center of its kind in American industry.

Fehr said the new laboratory would enable General Electric to expand their research and development programs to meet the demands of faster jet engines, guided missiles, automation and advanced power generating equipment, as well as household appliances of the future.

He pointed to air bearings as a possible way to make the breakthrough in extremely high and extremely low temperatures.

"In addition," he said, "we are studying the possibilities of using molten metals and molten glass for lubrication, which will enable us to go to higher speeds and higher pressures."

## Germanium Rectifiers Get Bigger

AN IDEA of the growing size and importance of germanium rectifiers in the field of power supply is given by a recent announcement by General Electric Company of an order from Diamond Alkali Company for an installation of germanium power rectifiers rated 35,000 kw at 250 v dc. This equipment will be used to provide current for a chlorine cell installation.

Up to now, the normal rating of this type of rectifier has been 150 v. This new equipment fills a long-standing need in the electro-chemical industry for conversion equipment rated between 150 and 400 v, and gives advantages in the lower voltage ranges that mercury arc rectifiers provide in the higher voltage ranges.

The complete system includes, in addition to the germanium rectifiers, metal-clad switchgear, transformers, induction voltage regulators, and instrument components.

**NEW TREND**

**Welding by alternating current has not always been the important factor in the welding industry that it is today. For many years all arc welding was done with d-c. This was natural because of the inherent ease of welding with a d-c power source. Once a d-c arc is established, the current continues to flow at a more or less constant value, and there is very little tendency for the arc to pop out. A-c power, on the other hand, is constantly fluctuating from a peak value down to zero, and the arc tends to pop out. Since the early 1930's, however, improvements in coated electrodes and a-c welding transformers have combined to make a-c welding a worthy competitor of d-c. Today, over 25 per cent of all arc welding is a-c, compared with only 5 per cent that obtained 20 years ago.**

# Understand A-C Welding Equipment?

By J. E. LENZ *

SINCE D-C produces a more stable arc, just what are the advantages of using a-c? Perhaps the most important advantage of alternating current welding is the elimination of arc blow. The frequent occurrence of arc blow found in d-c welding above the 200 amp range reduces both deposition rates and lowers weld quality. Thus, at high current settings, a-c welding provides a faster method of welding with higher quality weld deposits.

Additional advantages of a-c welding over d-c are: (A) lower initial equipment cost; (B) requires less maintenance, no rotating parts; (C) has higher electrical efficiency, thereby reducing power costs.

### Circuit Analogy

One of the most easily understood comparisons to an electrical circuit is the simple hydraulic circuit. Let's compare a basic transformer-type a-c welding power supply to a hydraulic system. Looking at Fig. 1, the rather large tank of water can be considered the source needed for the hydraulic system. The water is piped to a pump, which provides the necessary pressure to push the water through the system. A valve in the water circuit controls the amount of water going through the pipes. In order to justify the system, the water must flow through some load to perform a necessary and useful function. In this case a heat exchanger is the load and the water is used as a coolant in some industrial process. Then, in order to conserve water, the pipes return the water to the tank so that the water can be reused over and over again.

Now, this hydraulic system has a lot in common with an arc-welding system. In the first place, there is a power supply which provides an almost unlimited source of power, in the form of volts and amperes, commonly known as kva. The power supply is connected to a transformer, which steps the voltage down from the power line value to a lower voltage safe for welding. The transformer also provides the electrical pressure or electromotive force required to force the current, called amperes, through the circuit. A variable impedance device in the circuit controls the amount of current which flows, to give just the right amount for the application. In the case of the welding transformer, this impedance device is usually some form of a variable reactor. The current flows through the electrical load, which is the welding arc, heating up the work and electrode and providing the fusion required for a good weld. The current is then carried through a return wire back to its source in the transformer.

Comparing the two circuits again, in the hydraulic system there is a pump which provides pressure in pounds per square inch to force the water through the circuit. In the welding circuit there is a transformer which provides electrical pressure or voltage to force a current around through the circuit. A valve in the hydraulic circuit throttles the water to give just the right amount required by the load. Likewise, a reactor in the welding circuit provides just the right amount of impedance, expressed in ohms, so that the proper current will flow through the welding arc.

The hydraulic circuit has a load which requires a certain flow of water in gallons per minute in order to accomplish a useful task. The load in the welding circuit, the welding arc, requires a flow of current in amperes to produce heat. The tank in the hy-

* Welding Department, General Electric Company.

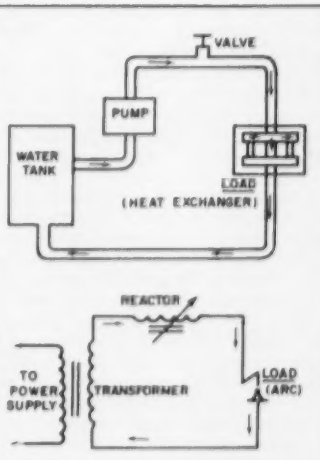



Fig. 1. Basic arc welding system (lower), hydraulic (above)

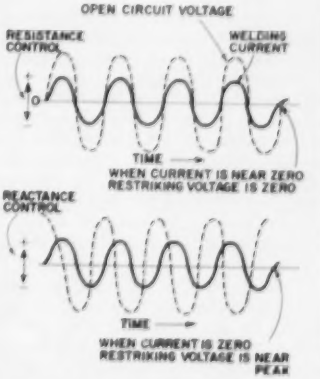



Fig. 2. Reactance control is more efficient, stabilizes arc

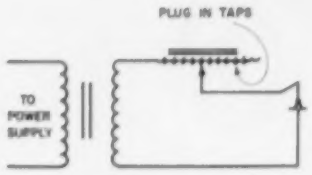



Fig. 3. Fixed tapped reactor is simple, easy to maintain

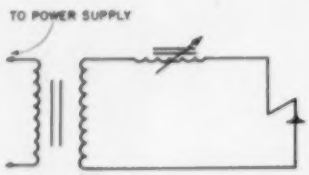



Fig. 4. Moving core reactor has stepless current control

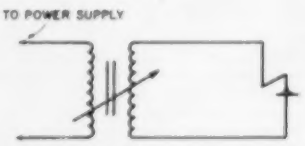



Fig. 5 Moving coil transformer requires little maintenance

draulic system gives a reservoir of water, a sufficient quantity to provide a constant and never-ending supply to perform the task. Likewise, the power company provides a reservoir of power in kva, which is always on tap in sufficient quantities required for the welding operation.

### Welding Current Control

Notice that a variable reactance is used rather than resistance to control welding current in the circuit. There are two good reasons for this:

First, the resistor wastes power and is therefore less efficient than the reactor. Secondly, reactance control provides better arc stability than resistance control. Let's see why (Fig. 2).

The upper oscillographic trace shows what happens to the volts and amperes when resistance is used to control the amount of current going through the arc. The solid trace represents the welding current which, in an a-c welder, is in the form of a sine wave. That is, it alternately flows through the wire in a positive direction, then reverses itself and flows through in a negative direction. These reversals occur at the rate of 120 times per second for a 60-cycle power supply, which means that the current actually goes through zero or stops flowing in the wire 120 times per second.

The dotted trace shows the open-circuit voltage of the welding transformer. This is the voltage available to re-establish the welding current as it passes through the zero value each half cycle. With resistance control, the voltage is "in phase" with the current; in other words, they reach a peak value at the same time and both go through zero at the same time. So it should be obvious that at the instant the current is going through zero, the re-striking voltage is also zero. In other words, at the very moment the voltage is needed to re-strike the arc, there is no voltage to do it; therefore, the arc will tend to "pop out," and it will be difficult to start and maintain an arc with this control.

The trace for reactance control shows that when current flows through a reactor, it has the effect of shifting the phase relationship between the voltage and the current, so that now when the current goes through zero, the available re-striking voltage is near its peak value. Thus at the critical instant when the arc tends to go out, there is a high value of voltage to re-strike the arc, and welding can continue without a pop-out.

Now that we have established that a reactor is the thing to use in an a-c welding circuit, which type of reactor should we use? Let's examine the merits of the several types of reactors which have been used in welding circuits.

### What Kind of Reactor?

Figure 3 shows a fixed tapped reactor. Here we tap off at a number of points of the reactor winding by the use of a plug, in order to give different reactance values. Such a welder has the advantage of extreme simplicity. Since there are no moving parts, there should be a minimum of maintenance, and it should be very quiet.

However, this circuit also has some serious disadvantages. Since its current settings are in steps rather than being smooth and stepless, in between values cannot be obtained, and current cannot be adjusted while welding. Also, the control does not lend itself to remote control of current at the welding station. Because of its inherent disadvantages, this type of current adjustment is seldom encountered in industrial-type welding equipment, although it has found a useful place in the light-duty, utility-type welders.

Next we will consider the *moving-core* type of reactor, in Fig. 4. Again, the reactor is separate from the transformer, but now a section of the iron core of this reactor is movable, and varying the length of the air gap in the magnetic circuit gives a smooth and stepless change in reactance. This results in a smooth and stepless change in current control. If it is properly designed, it will provide a rather wide range of current in one range of the welder. The current is adjustable under load, so that settings can be changed even while welding. It is moderately easy to add remote control by using a motor drive instead of a handcrank. Maintenance is increased somewhat by the introduction of moving parts, but it is still a relatively simple mechanical device.

A disadvantage of this moving-core reactor is that the current calibrations tend to become crowded at the low-current end, and accurate settings at this end are rather difficult. Also, the mechanical construction required to contain the heavy mechanical vibration of the moving core usually results in a rather stiff current-adjustment mechanism. A welder with this control tends to become noisy at the extreme low-current settings, as the moving core reaches its nearly-closed position.

In Fig. 5 we consider a *moving-coil transformer* type of reactance control. Here the separate reactor is eliminated entirely, and reactance is changed by moving the primary coil with respect to the secondary coil. The varying leakage magnetic flux provides a range of reactance adjustment, providing a stepless adjustment of current control. The current is adjustable under load, and the mechanical forces are spread out so that the effort of cranking when adjusting current is usually considerably less than with a moving-core reactor.

Another inherent advantage of this control is that the current indicator is spread out over a long length in a logarithmic fashion, and the settings at the low end of the scale are widely spaced, permitting very accurate current settings and resettings throughout the range. Also, a remote control may be obtained by adding a current-adjusting motor, and little maintenance is required.

A disadvantage of this control is the limited range of current without making the core and coil structure extremely tall, and it may be necessary to resort to two current ranges. This control has a tendency to become noisy at the extreme high-current setting, where the magnetic forces are greatest.

One other type of current control which should be considered is the *saturable core* reactor. Looking at Fig. 6, we see that the circuit again consists of a two-winding transformer plus a separate reactor, but now the variable factor of reactance is ob-

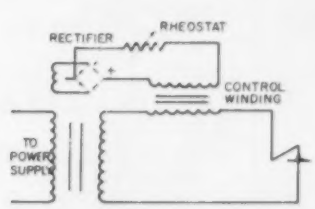
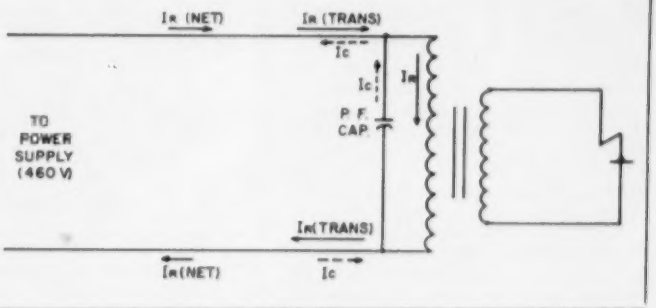



Fig. 6. Saturable core reactor. Fig. 7 (r). Adding power factor capacitors save money




tained not by a mechanical means, such as moving the cores or coils, but electrically. A separate low-voltage winding on the transformer is fed through a rectifier bridge, providing d-c to a control winding, which is wound on the core of the reactor. A rheostat is connected into this d-c control circuit to control the d-c current fed to the reactor control winding. The magnetic saturation effect of the d-c ampere turns on the reactor core controls the amount of reactance that the reactor will provide.

So again there are the advantages of stepless current control and a current which is adjustable under load. It is certainly easy to adjust, just a turn of the rheostat knob, and it usually lends itself to a wide single-current range. One additional important advantage provided by this control is that remote control is relatively simple, since the rheostat can be moved to the welding station and current controlled from that point.

However, there are also several disadvantages to this type of control. It has been complicated electrically by the introduction of the d-c control circuit, and there are more gadgets to get out of order, such as the rectifiers and rheostat; therefore, more maintenance may be expected. The current indicator cannot be as accurately calibrated with the saturable core reactor as with the other types of controls, and the dials are usually calibrated in reference numbers, rather than in actual amperes. The circuit is quite sensitive to changes in line voltages, and a relatively small change in line voltage may cause a wide fluctuation in welding current.

Among the various types of variable reactors which have been used for current control in an a-c welder, the choice of either moving core, moving coil, or a saturable-reactance control will provide an acceptable welder if properly designed. The choice is usually resolved by manufacturing considerations and by weighing the advantages and disadvantages of each system. A first-class industrial welder is not possible with a fixed tapped-reactor type of control.

## Power Factor Capacitors

The use of inductive reactance as a current-controlling device, which is desirable for good arc stability in an a-c welder, can be a big headache for the power company operators. The welder presents a low power factor load to the line, due to the large out-of-phase reactive component of current. In simpler terms, this simply means that the power companies' transmission lines, transformers, and distribution system must deliver a large percentage of wattless current, which loads up the system but does not produce revenue by registering on the watt hour meter. Their displeasure is often shown by charging the user with a kva demand-charge or a power factor penalty.

Manufacturers of a-c welders have solved this problem by adding power-factor capacitors to their welders; thus an undesirable load is converted to a very desirable load. Looking at Fig. 7, we see the power factor capacitors connected directly across the primary of the welding transformer. The large component of reactive current, $I_R$, caused by the welder, is substantially cancelled out by the capacitor current, $I_C$, which flows through the wire in an opposite direction. As a result, $I_R$ net, the remaining wattless current drawn from the power supply, is greatly reduced.

This makes everybody happy; the power company, because his system is no longer burdened with a large component of wattless current which returns him no revenue; and the power engineer, who can now save money because of the reduction in size of primary cables, fuses, switches, circuit breakers, and distribution transformer capacity. However, one point should be clearly understood; the addition of power factor capacitors to a welder does not affect its welding performance in any way.

## Open Circuit Voltage

Now let's consider another very important factor in the design of an a-c welder; that of *open-circuit voltage*.

Referring to Fig. 8, we remember that by controlling current output with reactance we made a much more stable welder. The shift in phase relationship made it possible for the open-circuit voltage peak to occur at the time the welding currents passed through its zero point. In fact, we might refer to this region of current zero as the "pop-out zone," since

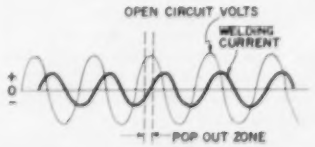



Fig. 8. Open-circuit voltage is important to design of welder

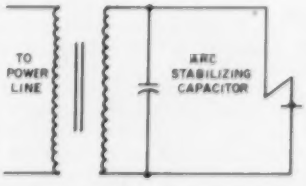



Fig. 9. Arc-stabilizing capacitors are added to the circuit

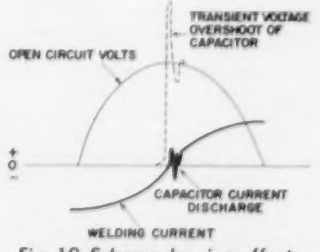



Fig. 10. Scheme showing effect of arc-stabilizing capacitor

invariably if pop-outs occur, they happen at one of these current zero points.

For an instant the work and electrode cool off, and the current becomes so weak that the arc may go out completely. If it does go out, and the re-striking voltage (open-circuit voltage) is not sufficiently high to re-ionize the arc path and force the current to start flowing again immediately, a pop-out results.

Naturally, the higher this open-circuit voltage, the more electrical force there is available to re-establish the arc, and the more stable the arc becomes. Other things being equal, the welder with the higher open-circuit voltage will have the better arc stability, especially noticeable at lower current settings. However, both NEMA (the National Electrical Manufacturers' Association) and the Underwriters' Lab have set a maximum limit of 80 v on the open-circuit voltage of an a-c welder, for safety reasons. Coated electrodes for a-c welders have been developed so that the vast majority of these electrodes on the market today give a very stable arc at open-circuit voltages between 70 and 80 v.

### Arc-Stabilizing Capacitors

Among a-c electrodes, there are a few bad actors in arc stability, the most common being the low-hydrogen electrode. Even at 80 v, occasional pop-outs may occur when using this electrode. To remedy this situation, *arc-stabilizing* capacitors are added to the circuit. Figure 9 shows that these capacitors are connected across the *secondary* winding of the transformer, which also places them across the welding arc. Arc-stabilizing capacitors should not be confused with power factor correction capacitors. You will recall that these are connected across the transformer primary and have no effect on welding performance. Arc-stabilizing capacitors do their job by giving the welding current a brief kick during the critical pop-out zone.

Let's examine the action of this capacitor. In Fig. 10, the scale of the oscillographic representation is expanded to show a single half cycle of current and voltage. Following the trace of the welding current as it reaches the zero point, let's assume that it tends to die out. Immediately the arc-stabilizing capacitor starts to charge up to the open-circuit voltage of the welder. The capacitor is charged through the inductance of the transformer, and the circuit provides an oscillatory voltage at a relatively high frequency. Although this oscillatory voltage is rapidly damped, the first few cycles provide a large transient voltage overshoot, as shown by the high peak on the oscillogram. This transient voltage is added to the open-circuit voltage which is applied to the welding arc, and provides the extra electrical force needed to re-ionize the arc path and re-establish the current.

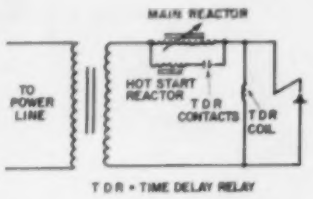



Fig. 11. Plan showing a-c welder with a hot-start circuit

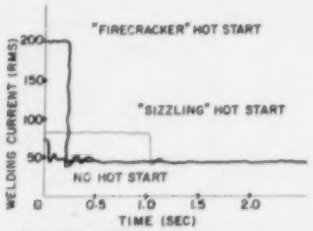



Fig. 12. Graph indicating effect of types of hot-start circuits

Additional help is provided by the capacitors when the arc path breaks down, as an oscillatory discharge of current from the capacitors helps to strengthen the arc ionization. By that time, the welding arc goes merrily on its way, blissfully unaware that it has come dangerously close to experiencing a pop-out. The net effect of the arc-stabilizing capacitors on arc stability is equivalent to an additional 5 to 10 v of open-circuit voltage; in other words, it makes a 70-v welder look like a 75- to 80-v welder, and it makes an 80-v welder look like an 85- to 90-v welder. Thus, additional arc stability can be obtained without increasing the shock hazard.

### Hot Start

Another refinement has been added to the a-c circuit which has received widespread acceptance during the last few years. This is the *hot-start circuit*. The same reasons that tend to make an a-c arc inherently unstable also tend to make it a difficult arc to get started, particularly at low currents. The hot-start circuit completely overcomes this difficulty.

Figure 11 shows a simplified circuit diagram of an a-c welder equipped with a hot-start circuit. The main reactor is paralleled by a hot-start reactor through the contacts of a time-delay relay (TDR). During the time when these contacts are closed, the two parallel reactors present a lower impedance to the flow of welding current than the main reactor alone; so, a higher current will flow.

The coil of relay TDR is connected across the welding arc. When it sees open-circuit voltage during idling periods of the welder, the relay picks up, paralleling the hot-start reactor with the main reactor. The instant an arc is struck, the voltage on TDR coil is low enough to start it timing out; however, during this time-delay period, current is limited only by the paralleled reactors, so that a higher-than-normal current is obtained. After the time-delay period of the relay the contacts open up so that the full reactance of the main reactor limits the welding current to its normal value.

Figure 12 shows two different types of hot starts.

One type of hot-start circuit, which we might refer to as the "sizzling" hot start, provides a rather moderate amount of current boost, but holds it on for a relatively long period of time, approximately one second, as shown on the graph.

Another type is the so-called "firecracker" hot start, which provides a very large amount of current boost, but for a much-shorter period of time, approximately 0.2 second, as shown. With this hot start the welding operator gets a big bang of fireworks, and then he's on his way.

### Voltage Reducing Control

A factor which has retarded the progress of a-c welding equipment has been electrical shock hazard.

During the early days of development of the a-c welding process, it was necessary to use open-circuit voltage values of 100 v or more in order to produce stable arcs. Several fatal and near-fatal shock accidents during this period gave a-c welding a handicap which has been difficult to overcome.

To overcome the shock hazard of a-c welding under adverse climatic conditions, an automatic idling voltage reducing control has been developed. Such a control provides a greatly reduced open-circuit voltage while the welder is idling, so that welding electrodes can be safely changed by the operator.

It has been demonstrated that voltages as low as 15 to 20 v are necessary to insure shock immunity under the worst possible conceivable conditions of body contact. However, such low voltages prevent reliable operation of the control circuit due to oxides and scale on the work, and an insulating crust which forms on the end of the electrode. Therefore, a compromise voltage of between 25 and 35 v is usually used.

An important design requirement for this circuit is speed of pick up. A contactor pick-up speed of no more than one or two cycles is required for easy starting.

Welders equipped with voltage-reducing control are more difficult to start and require more maintenance than conventional a-c welders, even with the best designed circuitry.

# How To Size An Exhaust Hood

By J. D. CONSTANCE

HOODS SHOULD be located close as possible to the source of heat and vapor to keep air-handling quantities and attendant power costs to a minimum. Vapors and gases are dispersed primarily by immediately adjacent air currents. Open doors and windows, movement of nearby workers, machinery, and temperature changes affect hood efficiency in this manner, and, if not brought under control or eliminated, vapors and gases will not be brought under the influence of the hood exhaust.

Minimum control or capture velocities have been established [1] for various operations and range from 50 to 500 ft per min. These capture velocities are needed to overcome opposing or disturbing air currents and to capture the hot or contaminated air and cause it to flow into the hood. The following table gives several capture velocity ranges of practical use.

Range of Capture Velocities [1]

| Examples | Capture Velocities |
|---|---|
| Evaporation from tanks | 50 to 100 |
| Spray booths, intermittent container filling, welding, low speed conveyor transfers | 100 to 200 |
| Spray painting in shallow booths, barrel filling, conveyor loading, crushers | 200 to 500 |

For the type of hood in question the following formula has found practical application:

$$Q = 1.4\ V.\ P.\ D,$$

where Q is air to be exhausted in cfm, V is capture velocity in fpm, P is perimeter of hood face in ft, and D is vertical distance from source of heat or contamination to hood entrance in ft.

To simplify use of this equation, the accompanying graph has been developed; it gives a range of capture velocities as low as 25 ft per min. Generally, a capture velocity of about 100 has been found the most practical.

[1] Reference "Industrial Ventilation", American Conference of Governmental Industrial Hygienists, 1951.

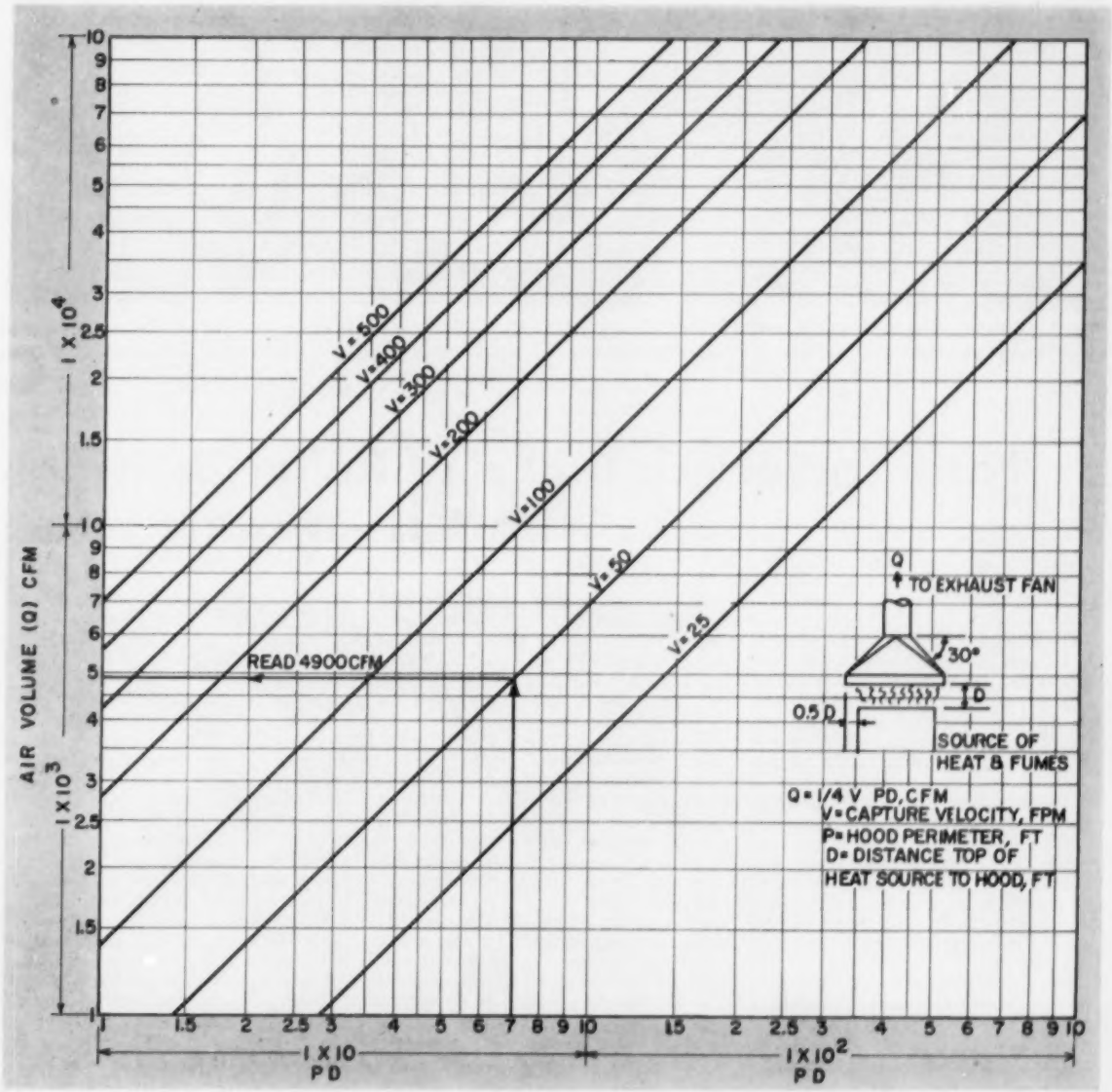


Fig. 1. Bearing lubrication is essential part of regular maintenance program. In dirty locations, like coal conveyors, cover fittings with caps obtainable for this purpose; if not covered, wipe off each fitting before applying gun

# How To Service Ball and Roller Bearings . . . . Part II—Maintenance

By E. P. STAHL*

PROPER LUBRICATION of anti-friction bearings is one of the most important phases of anti-friction bearing maintenance. Every plant has different requirements, but each should maintain some type of lubrication schedule suited to its equipment.

Lubrication problems of maintenance men can be simplified by the use of tags or decalcomanias on machines, as illustrated in Fig. 3, for lubrication identification. This method consists in attaching a tag to each lubrication fitting or a decal to the bearing housing carrying a series of numerals.

With this arrangement, first numeral indicates the number of strokes of the grease gun required to supply the correct amount of lubricant to the bearing; second numeral gives the identification number of the lubricant to be applied; third numeral shows frequency of lubrication. With the tag and decal illustrated, the numeral 1 indicates the bearing should be lubricated yearly, 2, semi-annually, 4, quarterly, and 12, monthly.

### Information At a Glance

With these identification numbers, a maintenance man can tell at a glance which bearings require lubrication, how much of what kind of lubricant is needed. For instance, the tag and decal illustrated indicate that three strokes of the grease gun are necessary to supply the required amount of lubricant. The numeral 2 identifies the type or kind of lubricant to be used, and the numeral 4 shows the frequency, which in this instance, is every three months. This method of identification saves time and work on the part of the maintenance men particularly where several different kinds of lubricants are used in a machine, and also eliminates the necessity of consulting records for each machine.

[*Editor's Note:* There are many other methods of scheduling and identifying machine lubrication points. A method that has proven successful — particularly for complicated equipment with many lubrication points — is employed at Eastman Kodak Co. For such equipment, a photograph is made and the lubrication points called out with a suitable legend appended, as shown in Fig. 2.

This method can be applied to many different types of machines and it has been found to be very successful in practice. The composite photos can be mounted on stiff cardboard mountings, lacquered, coated with

*The Garlock Packing Co., Palmyra, N. Y.

plastic from pressure spray cans, or covered with transparent acetate.]

Bearing manufacturers emphasize the necessity of draining or washing ball and roller bearings in a machine at regular intervals wherever and whenever possible; cleaning is followed by replenishment with fresh lubricant. As one maintenance man has said, "give your bearings a physic whenever possible."

Washing and purging bearings pay dividends in the long run. Sludge or solid matter tends to clog oil passages and ducts to the bearings; excessive wear and friction may result from reduced lubricant supply. It also interferes with the free action of the bearing balls or rollers themselves. Gummy deposits formed by oxidation of the lubricant under high-temperature and high-speed conditions act in the same manner. To get the full measure of service and life expectancy out of ball and roller bearings they need to be purged or flushed at regular intervals.

### Remove Bearings To Clean

It is better to clean bearings by removing them from the housings whenever possible. If it is not possible to dismount them, hot, light oil at 180 to 200 F may be flushed through the bearing housings while the shafts or spindles are slowly rotated. In cases where the lubricant is badly oxidized, hot aqueous emulsions, made from standard cleaning compounds, may be run in the housings while rotating the shafts slowly.

Cleaning solution must be completely drained from the bearings with the shafts rotating; then the bearing and bearing housing must be flushed with hot light oil or kerosene and again drained before adding new grease or oil. In some very stubborn cases, an intermediate flushing with a mixture and light solvent after the emulsion may be necessary.

In ball and roller bearing equipped machines subjected to high temperatures, such as are encountered in steel mills, the lubricant is apt to cake so that oil passages are often plugged. In cases like this it is not always necessary to shut down and dismantle the equipment. It is frequently possible to clean a system by circulating an approved high-flash solvent at a relatively high temperature through the system.

In separate bearings where the grease fitting is on one side and the drain plug on the other, the drain plug can be removed periodically and fresh grease forced through the bearing to purge any remaining contamination. After this operation the bearing should then be run until new grease shows up at the drain plug opening, as excess lubricant will cause overheating of the bearing.

A relief-type lubrication fitting (Fig. 5) is available for use on any antifriction bearing housing equipped with standard relief or drain plugs.

This fitting has an attached flip-open cap that allows discharge of excess grease but cannot be lost.

Ball and roller bearings suffer more from overlubrication than underlubrication, consequently, maintenance men should take every precaution to guard against applying too much lubricant.

### Personnel Should Be Trained

To prevent misuse and misapplication of lubricants, only well trained personnel should be permitted to handle them. Every lubricant container should be properly labeled; only one type of grease should be used in any one gun and the gun should be clearly marked. These precautions will prevent many headaches for the maintenance department.

Before starting a bearing installation or removal job, maintenance men should make sure all installation and removal tools and spare parts are available.

The maintenance man should take a few moments to study the assembly and determine the best way to get

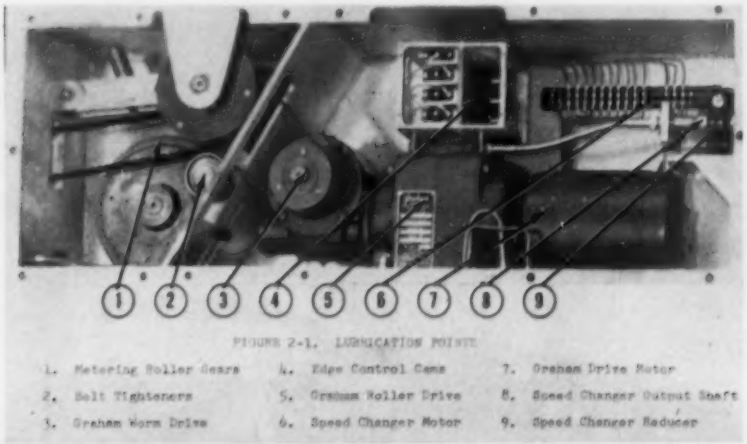



Fig. 2. System adopted at Eastman Kodak to ensure that complicated mechanism gets proper lubrication. Lube points are called out on photograph with legend

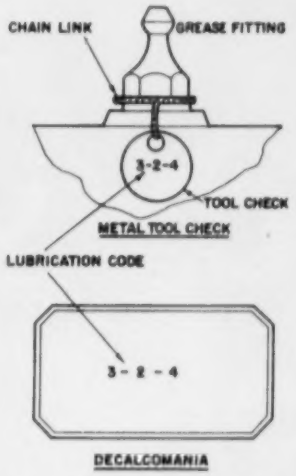



Fig. 3. Simple coding method uses metal tool check or decal

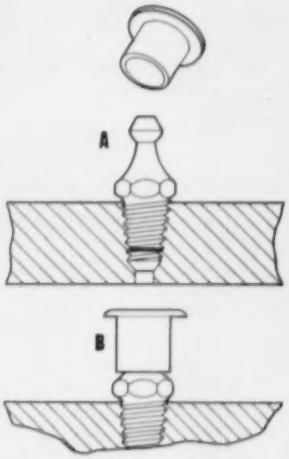



Fig. 4. Colored plastic caps shield and code lube fittings

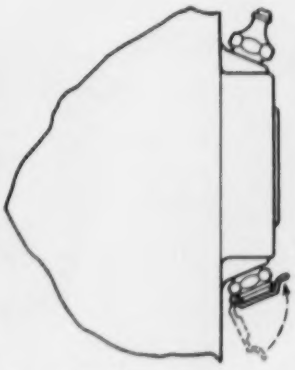


Fig. 5. A new relief fitting replaces old style drain plug

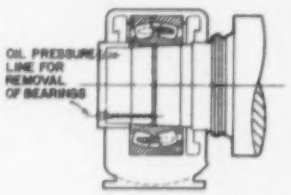



Fig. 6. A pressed-on bearing utilizing hydraulic pressure system to force bearing off tapered seat. Note oil lines

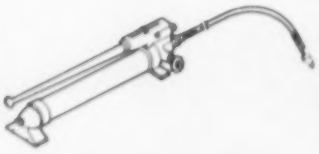


Fig. 7. An hydraulic pressure pump with hose for removing a bearing like that shown above

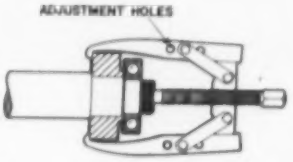



Fig. 8. Simple bearing puller. Many models are available for all types of bearing removal jobs. Investment is negligible

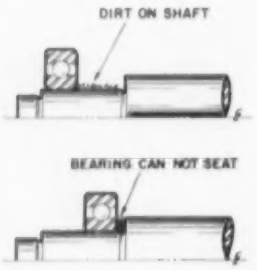



Fig. 9. Dirt on bearing seat should always be wiped off before installing bearing. Dirt at shoulder prevents seating

the bearings out of the machine. A study of the assembly drawing of the piece of equipment to be dismantled is often helpful. The next step is to be sure there are efficient removal tools.

Plan ahead for repair periods so that the job may be completed speedily and successfully. In general, there are three methods to pull bearings from shafts: bearing puller, as shown in Fig. 9, arbor press, as shown in Fig. 10, and a drift and hammer. Of these three methods, the puller method is preferred. Least desirable is the drift and hammer method, but if this is unavoidable, use a small metal drift pin, *on the inner race only*, and tap alternately around the circumference of the bearing to prevent it from cocking on the shaft.

Bearing seals should be removed with seal pullers, of which one type is shown in Fig. 12. This puller is inserted in the seal, the head expanded to grip the seal, then the sliding hammer is brought back sharply to strike against the end handle. One or two strokes usually jars the seal out of the housing.

In general, it is good practice to replace seals that have been removed. If handled carefully, however, and if they have not seen long service, used seals can sometimes be replaced with safety. When in doubt, use a new seal.

### Clean Before Inspection

Condition of bearing races and balls or rollers can be determined only when all traces of old lubricant or dirt are removed. Although cleaning or washing a bearing is a simple process, certain precautions are necessary if it is to be done properly.

Use a clean metal pail or receptacle. Pour into it one or two quarts of an approved solvent, such as kerosene or Stoddard's solvent; dip bearing into the liquid and revolve it slowly by hand. Repeat until all traces of grease have been removed and bearing "feels" smooth.

Handling bearings during cleaning is easier if you make a simple tool like that shown in Fig. 13. This tool is made from a length of $\frac{1}{8}$-in. drill rod bent to shape for holding bearing sizes most frequently encountered in your work. Drill rod is better than cold-rolled stock since even without heat treatment drill rod retains the spring-like quality that makes the tool useful. To hold a bearing, slip the tool through the bore; the lips will keep the bearing from falling off.

### Use Clean, Dry Air

When all traces of old lubricant and dirt have been removed, blow out the bearing *with clean, dry air.* (Air lines without filters should not be used: moisture is always present in such lines, and when this is blown into a bearing, rusting inevitably occurs.) Hold the two races together so the bearing does not spin, but permit the inner race to rotate a few turns now and then to dislodge the liquid and foreign particles from the retainer pockets. Caution: *Never spin a dry bearing with air.* Extremely high speed is generated by this practice and unlubricated bearings can be scored in a fraction of a second.

If the bearing is very dirty, it is advisable to rinse it in a second clean solvent bath. When the bearing is dry, coat it immediately with lubricant or a rust preventative — especially the race grooves, balls, or rollers. If unprotected, these highly-polished parts corrode rapidly. It is not wise to use oil in bearings that are grease-lubricated in service; oil on the bearing surfaces may prevent grease from adhering to the metal bearing surfaces when the bearing is first put into service.

Do not use gasoline containing lead or other antiknock compounds; these additives are injurious when absorbed in skin cuts or inhaled. Unleaded gasoline is suitable for cleaning, but it is highly inflammable and precautions must be taken to prevent fire. Remember that the invisible fumes are insidious and explode readily. High-flash-point solvents are

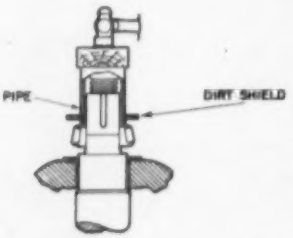



Fig. 10. Pipe fixture helps proper replacement of roller or ball bearings. Note dirt shield ring welded in place

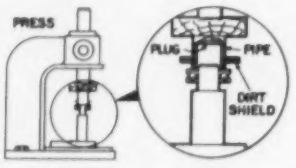



Fig. 11. Similar type fixture does same job in arbor press. Be sure that pipe diameter is of size to bear on inner race

much to be preferred from the safety standpoint.

When a number of bearings are to be cleaned, use of a metal basket with a coarse screen bottom is recommended. Basket should be capable of being suspended in the liquid container so the bottom of the basket is clear of the container bottom. Let the bearings soak in the cleaner, moving them occasionally to distribute the liquid. After they have soaked sufficiently to loosen hardened lubricants, rinse by dipping the basket up and down in the liquid, then remove bearings, let drain, and give them a final individual cleaning in fresh solvent as previously described.

Avoid piling a large number of bearings one on top of the other in the basket; loosened dirt will sift from the upper layers into the lower bearings, making the cleaning job more difficult.

### Guard Against Rust

Cleaned, inspected bearings considered to be in serviceable condition, but which cannot be installed in equipment the same day, should be coated with lubricant or rust preventative and stored overnight in clean covered containers.

If a cleaned bearing is to be put back in stock, wrap it separately in grease-proof paper to keep it clean and to prevent lubricant from escaping. When individual bearing boxes or cartons are not available, give bearing a final wrapping in water-resistant paper and mark package with bearing number. Never wrap bearings to be stored in cloth or ordinary paper. These materials soak up lubricants from the bearing, leaving it dry and open to moisture attack.

Bearings which are shielded on only one side can usually be cleaned in the manner described; more care must be used in the process, but hardened lubricant and dirt can ultimately be dislodged. Double shielded bearings, however, are not susceptible to good cleaning. It is better to discard them if they feel rough; cleaning fluid may get into the bearing, but it will not be able to move dirt out.

If a double shielded bearing feels smooth when removed for inspection, replace it untouched. Some few of the smaller ball bearings that are double shielded have small holes in the outer metal shield for introduction of fresh oil by means of a hypodermic needle that pierces the inner non-metallic seal. A few drops in each hole is sufficient for these bearings.

When reinstalling cleaned or new bearings in equipment, be sure bearing is prelubricated with the type of lubricant required in service. Don't depend only on the initial lubrication of the completed job to get lubricant to the bearing.

Before pressing a bearing on its shaft, make certain that the bearing seat is wiped clean. If dirt is present, it will be pushed along the shaft to the shoulder where it will interfere with full seating of the bearing. On closely fitted work, a few thousandths of an inch at this point can add up to thrust on a bearing not designed to handle it.

### Expand Bearings To Fit

Sometimes bearings must be expanded slightly to fit on their shafts. This can be accomplished by heating them in a hot oil bath — around 180 to 200 F (Fig. 14). If the bearing is large enough, the inner race can be heated by the method shown in Fig. 15. An ordinary light bulb is mounted as shown in an enclosed box, and the bearing supported by plywood shelf.

Before the equipment is put back in service, give it a test run and listen for unusual bearing noise. A device similar to that in Fig. 16 will telegraph sound excellently.

A final word. Do not let a machine stand idle for months without turning it over regularly. Oil will run off a standing bearing and may permit the upper unprotected part to become corroded. Make it a practice to have a regular schedule of turning over idle machinery at least once a month.

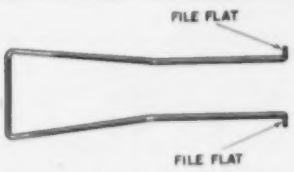



Fig. 13. Handy tool for holding bearings during cleaning; make few sizes from drill rod

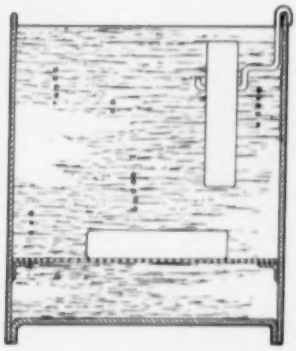


Fig. 14. Sheet metal tank for heating bearings with hot oil

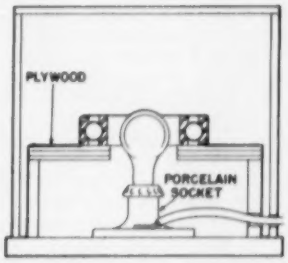



Fig. 15. Method of heating a large bearing to expand bore; an ordinary light bulb is used

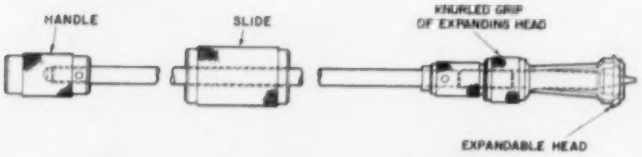



Fig. 12. One type of puller for removing bearing seals from housings; head of tool is inserted through bore of seal, the head expanded to gripping position, and the slide drawn back sharply against the handle. Hammer action pulls out seal

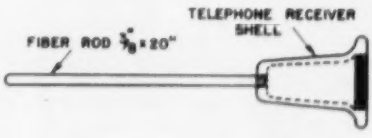



Fig. 16. Device for listening to bearing noise. Rod is held to housing, receiver to ear; other ear-pieces can be made

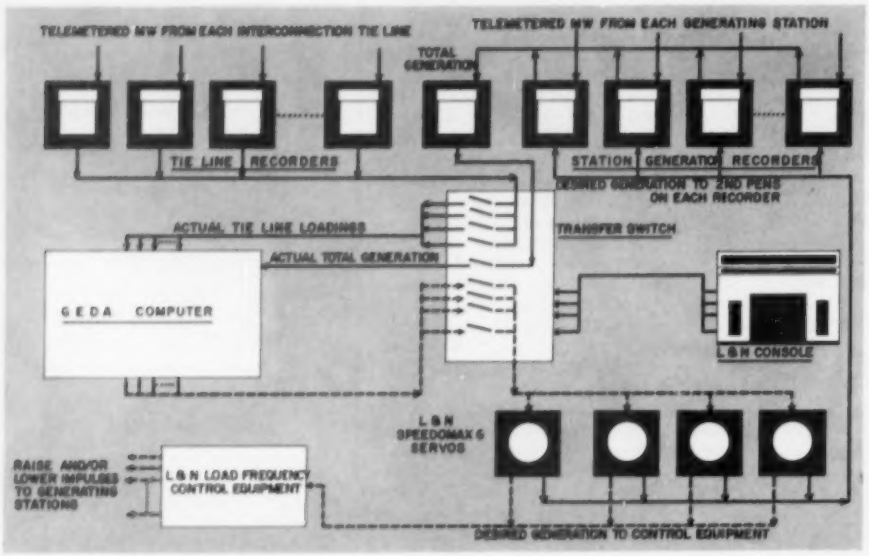

TELEMETERED MW FROM EACH INTERCONNECTION TIE LINE
TELEMETERED MW FROM EACH GENERATING STATION
TOTAL GENERATION
TIE LINE RECORDERS
STATION GENERATION RECORDERS
DESIRED GENERATION TO 2ND PENS ON EACH RECORDER
ACTUAL TIE LINE LOADINGS
TRANSFER SWITCH
ACTUAL TOTAL GENERATION
G E D A COMPUTER
L & N CONSOLE
L & N SPEEDOMAX G SERVOS
RAISE AND/OR LOWER IMPULSES TO GENERATING STATIONS
L & N LOAD FREQUENCY CONTROL EQUIPMENT
DESIRED GENERATION TO CONTROL EQUIPMENT

Fig. 1. Diagram of the Goodyear Electronic Differential Analyzer used on the Ohio Edison Co system for complete automatic economic dispatching

# Electric System Design and Operation

**Automation reaches new heights in power industry, with computers taking over economic dispatching of large interconnected systems. American Power Conference papers emphasize system problems**

IT WAS, PERHAPS, significant that the five electrical sessions of the American Power Conference were concerned almost entirely with electrical *systems* rather than with individual items of electrical apparatus. As the demand for electrical energy grows, system design and operation becomes of ever-increasing complexity and importance.

In the field of large high-voltage systems where many generating sources and heavy load centers are involved and which may be interconnected with other systems, manual control is no longer adequate and electronic computers take over the job of controlling systems automatically. In many instances, computers merely tell the load dispatchers what to do, but on several systems the computers actually effect the control; that is, they switch generators on and off, select the proper circuits for the most economical transmission of power, calculate incremental cost of power at load centers, and values of power at tie points with other systems. They do everything human load dispatchers do, but faster and better.

The operation of such an automatic dispatching computer — controlling The Ohio Edison Company's system — was the subject of an interesting paper by R. H. Travers and S. B. Yochelson. Prior to the installation of this equipment a modern load-frequency control system (Leeds & Northrup) had been installed, and extensive research was conducted with other companies into the development of mathematical equations expressing transmission network losses, and the coördination of these losses with generating costs.

Meanwhile, the Goodyear Aircraft Corporation had developed general purpose analog computers capable of solving complicated mathematical equations on a continuous basis and after a period of joint development with this company a suitable computer was installed. At first the computer merely furnished the data which the dispatchers used to control the system, but after a short time the computer was integrated directly with the system so that the computer itself controlled the system.

The function of the computer is to adjust continuously the regulating point setters of the control equipment to their most economic points. So far, this method of control has operated satisfactorily with little trouble. In addition to its use as an automatic system controller, the computer has

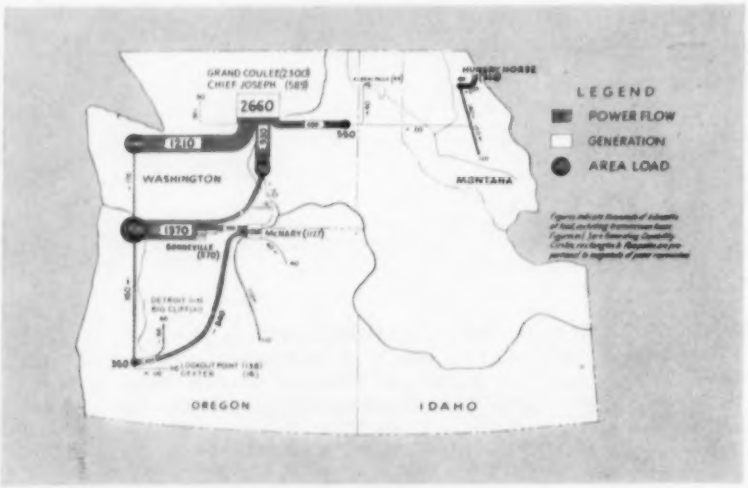



Fig. 2. Actual peak power flow on the Columbia River System as of January 1957

other uses and it may be switched out of the control chain at any time and simultaneously return the control of the system to the load control console for manual operation.

Despite this trend toward automatic control, one of the largest power systems in this country, that of the Tennessee Valley Authority, is still under manual control. As described in a paper by C. L. Karr and C. P. Almon, both of TVA, this system has a maximum load of over 9 million kilowatts. Power is transmitted over 5300 miles of 161-kv primary transmission lines and an equal number of miles of 46- and 69-kv subtransmission lines.

The many widely distributed hydroelectric generating stations, the size and locations of the steam-electric station (Kingston and Shawnee both over 1,350,000 kw), the magnitude and variations of the individual load blocks and the transmission losses offer a challenge to see that the generating plant and interconnected tie-line schedules give the lowest cost of power delivered after considering system limitations. Among the widely varying loads on the TVA system is the Arnold Engineering Development Center at Tellahoma, involving wind tunnels with a load totaling over 388 mw.

Because of the size of the AEDC loads and the probability of its instantaneous reduction when models being tested fail, TVA and AEDC have installed a remote-trip scheme to shed hydro generation to compensate for loss of AEDC load. This scheme initiates a trip signal at AEDC on predetermined amounts of load reduction at fast reduction rates.

The trip signal is transmitted over power lines to Chickamauga Dam and is then broadcast over power line carrier to trip generator units. Any one of 31 units at 5 hydroelectric stations can be selected to be tripped. Potentially as much as 1000 mw could be dropped.

Another interesting factor in the operation of the TVA system is the Hiwassee pump/turbine unit which provides a normal generator capability of 68 mw and uses up to 78 mw when run as a motor. Careful scheduling of its operation is required because of its remote location with respect to load centers and off-peak generation sources.

In the operation of the TVA system, a study of demand and energy requirements and supply is made every month for each of the 12 months as a guide for power operations. Each week a detailed related study is made to estimate the energy requirements and supply by weeks for the next six weeks. A weekly load estimate is made and an economic balance of generating costs of power delivered to the load is made, and from this, a load schedule by plants is determined. Based on the hourly estimated loads an individual plant schedule is developed for each hour of the succeeding day to meet the sustained load changes with the most economical power sources.

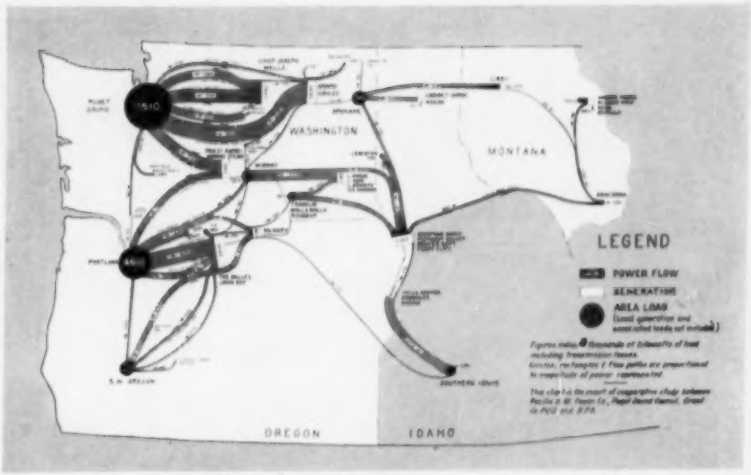



Fig. 3 Anticipated power flow on the Columbia River System as of January 1975

Mr. Karr, Director of Power Operations of TVA, who presented the paper said that they have been studying possible automatic operation of the system by computers but that at the present time computers are used only to solve the mathematical equations needed in their system control.

Operation of load-frequency control on a much smaller system than TVA — that of the Northern States Power Co, — was described by E. C. Glass of that company. The purchase of load-frequency control, said Mr. Glass, in the light of anticipated interconnections with their attendant responsibilities, was not so much a matter of choice as it was a necessity.

On this system also a Leeds & Northrup automatic load-frequency control system is installed. By means of high speed variable frequency telemetering, measurement of power flow on the various interconnections is transmitted to the System Dispatching Office. *continued on page 122*

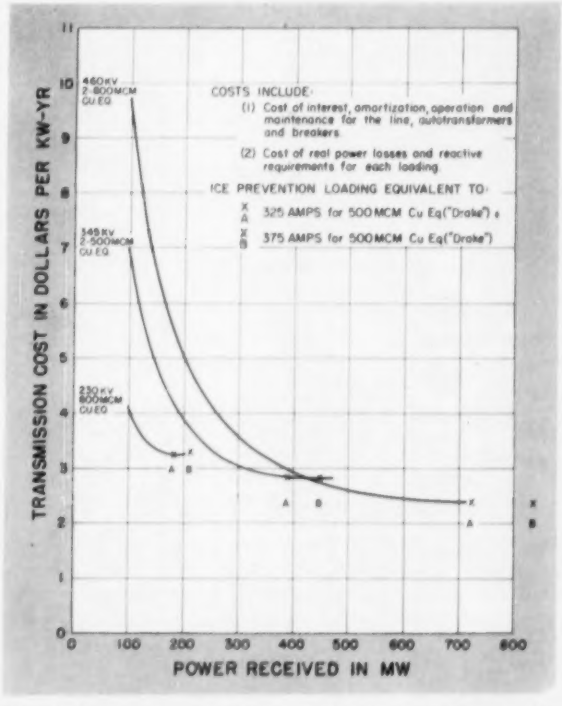

TRANSMISSION COST IN DOLLARS PER KW-YR
POWER RECEIVED IN MW
460KV 2-800MCM CU EQ
345KV 2-500MCM CU EQ
230KV 800MCM CU EQ
COSTS INCLUDE:
(1) Cost of interest, amortization, operation and maintenance for the line, autotransformers and breakers
(2) Cost of real power losses and reactive requirements for each loading
ICE PREVENTION LOADING EQUIVALENT TO:
X A 325 AMPS for 500 MCM Cu Eq("Drake")
X B 375 AMPS for 500 MCM Cu Eq("Drake")

Fig. 4. Annual transmission costs for transmitting electric power over a 200-mile line at various transmission voltages

# Symmetry—
## The Answer to Selective Action in Commutators

ONE OF THE BIGGEST problems encountered by men who operate and maintain sliding contacts on motors and generators is selective action.

Selective action is the condition which results when the brushes on a machine do not divide the load equally, with the result that there is distress to the commutator surface or ring surface and rapid, unequal brush wear. The distress to a commutator surface usually is a threaded or streaked condition which progresses in a cumulative manner. However, in some cases of selective action, one brush or one group of brushes can become overloaded to the extent that they actually start to burn.

This whole subject of better commutation is discussed very helpfully by J. V. Dobson and D. R. Dobson in Westinghouse's *Maintenance News*.

### Symmetry—Magic Word

The Dobsons point out that the magic word in operating a machine without encountering selective action is symmetry. The electrical connections that are paralleled must be of uniform potential. This includes the sliding connection between the brush and the commutator or slip ring surface. The potential between a brush and a commutator or ring surface is called contact drop.

The contact drop is influenced by the brush grade, the brush pressure, the brush fit and the condition of the film on the commutator or ring surface.

Some brush grades have film-forming properties; others have various degrees of cleaning action. Naturally brushes which establish a film have a higher drop than brushes with cleaning action added to prevent the build-up of a film, assuming of course that atmospheric conditions are the same for each case.

Since the contact drop varies between brush grades, it is not good practice to mix grades on one machine. Brushes with the lowest drop will take more than their share of the load. This can progress to the extent that on one machine some brushes will be working overloaded while a light load running condition can exist on others.

Sometimes brush grades on a machine are mixed intentionally. This may be done, the Dobsons explain, when it is necessary to add cleaning action to overcome some bad atmospheric conditions. On those occasions where it is considered desirable to add cleaning brushes, they should be added in a symmetrical pattern so that the number of cleaner brushes in any one arm and in any one brush path is uniform. In cases where the number of brushes per arm and the number of arms are not in the right ratio, it is impossible to come out exactly even, but the ratio should be held as close as possible.

### Brush Pressure

Variations in brush pressure can cause differences in contact drop resulting in selective action. The first thing to consider in adjusting brush pressure is the spring. If a brushholder is overloaded, the resulting high temperature can anneal the springs, which will materially reduce the spring pressure. Also, pressure springs can fatigue, particularly if they have been operated on an extremely rough commutator.

Spring pressures should be periodically checked and set at the value recommended by the machine manufacturer. A spring scale equipped with a leather or wire loop to slip under the pressure finger should be used. The pull should be taken in the direction of brush motion, to avoid values different from those affecting the brush in operation. Dividing the tension by the cross sectional area of the brush in square inches gives the brush pressure per square inch. Normal pressure values for various types of machine follows this general pattern:

| | |
|---|---|
| Industrial D-C machines | 2-2½ psi |
| High speed exciters | 2½-3 psi |
| Diesel generators | 4½-6½ psi |
| Auxiliary diesel generators | 2½-5½ psi |

### Brush Clearance

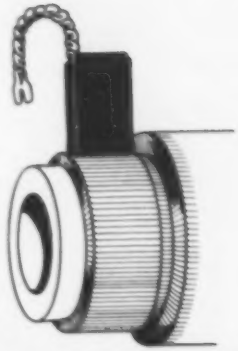
Brushholders whose clearances are too large or too small can also affect the pressure of the brush on the commutator. Large tolerances are only troublesome in radial brushes in reversing service where too much play will permit double faces to form on the brushes. This condition causes excessive arcing due to the narrower effective brush face and the resulting change to the commutator zone, as well as selective action resulting from variations to the contact drop.

Brushholders which are too snug cause the brushes to be held up. This effectively lowers the presssure of the brush on the surface, causing a variation in the contact drop and resulting in selective action.

Standard tolerance for brush thickness is +0.000 −0.004, and for brush width is +0.000 −0.015 for brushes over ¾-in. wide. The average industrial type of brushholder maintains a tolerance of +0.003 to +0.006 on thickness and +0.002 to +0.010 on the width dimension.

If your maintenance checks indicate clearances outside these limits, the Dobsons advise that the brush and brushholders should be checked. Look for brushholders that have been warped by a flash or overheating. Look for burrs or dirt inside the holders.

When installing new brushes, every



precaution should be taken to insure that the brush fit is uniform and that they make contact over the entire bearing face. After the brushholders have been checked for proper adjustment, the brushes should be seated by drawing a sheet of sandpaper under the brushes in the direction of rotation while pressing them firmly against the commutator.

As has been pointed out, selective action has a cumulative tendency; and if new brushes do not start out as uniform fits, a selective condition can get started which will gradually build up to troublesome proportions.

### Atmospheric Conditions

Bad atmospheric conditions can cause an undesirable film on the commutator surface. This film is usually high in resistance, and to permit passage of current it must break down. After the film breaks down, there is a variation in contact drops which naturally leads to selective action. Unless a brush is used with sufficient cleaning action to prevent the build-up of the film, or a brush is used whose film-forming influence may develop a satisfactory film of copper oxide before the obnoxious film can be established, selective action will result.

### Brush Shunts

Electrical paths from the brushes through the shunts to the terminals and through the terminals clear on through to the bus bars must be symmetrical to insure that each brush and each brush arm takes its share of the load. The potential drop across all joints in parallel must be uniform. All terminal connections and bolted joints must be pulled



POWER ENGINEERING HANDBOOK

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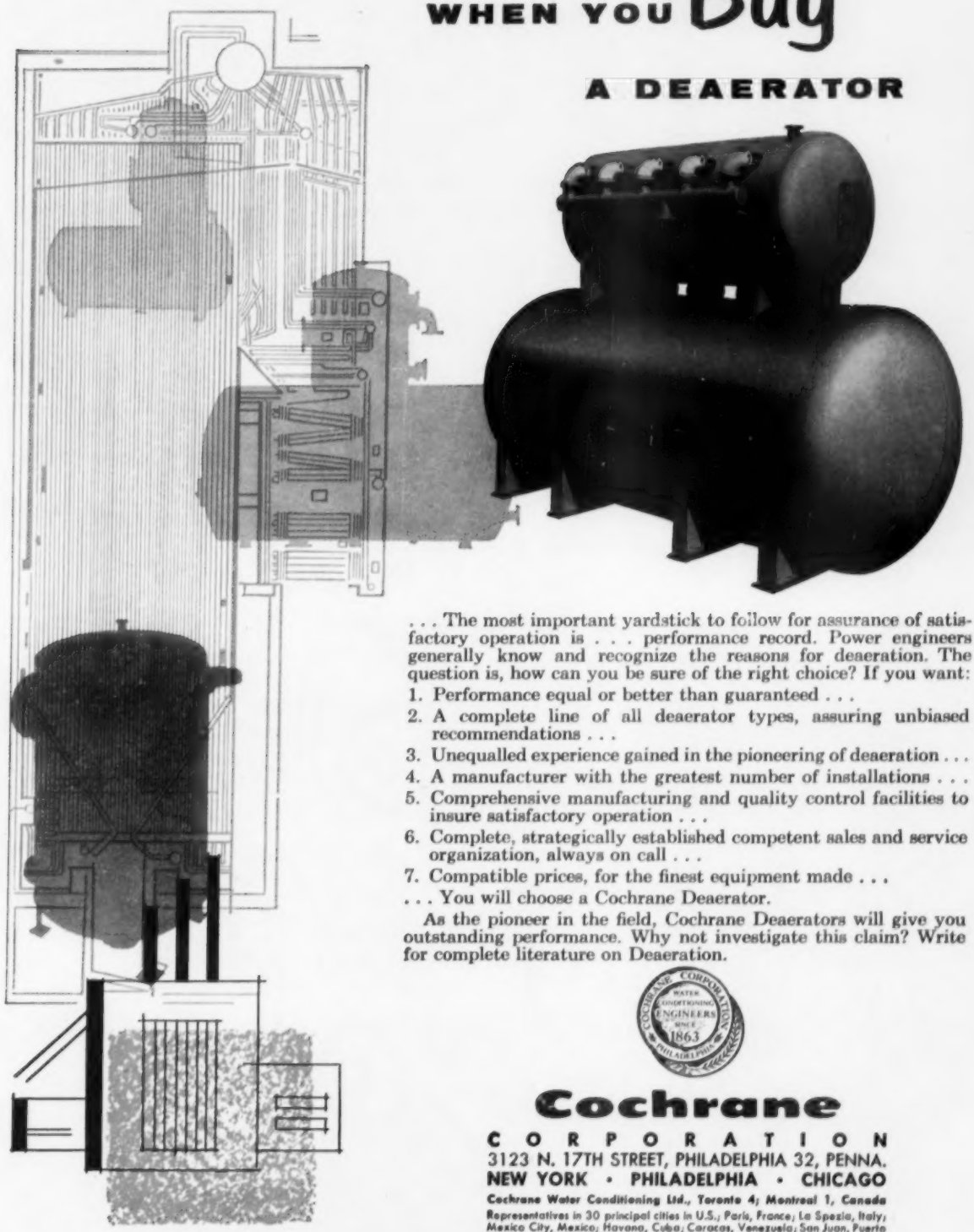

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up solid. If a machine is to be painted, all surfaces where electrical joints are to be made must be protected to prevent them from being insulated.

Brush shunts are universally made of stranded copper wires, each wire being approximately 0.005 in. in diameter; the size and number of shunts being determined by the maximum total current each brush will be expected to carry. This type of wire gives maximum flexibility without exerting any appreciable pressure on the brush. However, copper will fatigue and if a shunt is located in an air stream where it will get excessive vibration, or if it is unduly vibrated mechanically, the small wires will break and the shunts will fray. The resistance of frayed shunts is high, symmetry is disturbed and selective action results.

#### Shunt Connections

Connection of the shunt to the brush is accomplished either by riveting or by tamping. Both techniques have been improved to the point where they are rarely the cause of failure.

However, if the connections do fail, especially if they fail electrically without visible failures to the material, the resulting unbalance always resolves in selective action and it is quite difficult to locate. It would be false economy to recommend a maintenance procedure other than a visual check of shunt connections. But if selective action is a problem and the underlying cause is not immediately apparent, the drop across the shunt connections should be checked for uniformity.

There are other causes of selective action too numerous to mention that tax the ingenuity of the maintenance man. But as the Dobsons point out, the underlying problem is always the same — lack of symmetry. Find out where conditions are not uniform and you have found the cause of your problem.

## Tips on Soldering and Welding Copper, Brass, Aluminum

By PAUL C. ZIEMKE

ONE MOST IMPORTANT requirement for any soldering job is care in the selection and use of the flux. The fluxes best suited to the 50–50 and the 95–5 solder for use with an "iron" are in paste form. They consist of a petrolatum impregnated with ammonium chlorides.

When soldering copper, it is a fallacy to assume that the flux should clean the copper; but if the copper has been cleaned in advance, the flux will remove all traces of oxide. It will also protect the working area from the effects of oxidation during the heating-up process. The flux serves to float out the remaining oxides ahead of the solder, and assists in the wetting action of the solder in contact with the copper surface.

Compared to liquid fluxes, the paste fluxes will stand a moderate amount of overheating without losing their effectiveness. Liquid fluxes may serve the purpose of removing oxides, but generally have none of the other functions of a good flux.

Some experimenters have succeeded in developing a liquid flux containing powerful ammonia compounds which are supposed to clean the copper without the use of "elbow grease." These are dangerous, for various reasons, and should be avoided.

A recent paste flux is said to clean copper, without time spent in cleaning by hand. It will only serve reasonably well if the copper tube or fitting is quite clean to begin with.

For brazing, the type of flux selected will depend on the filler metal. For best results, the flux recommended by the manufacturer of the filler metal should be used. Filler metals of the phosphorous group are generally self-fluxing and no other flux is needed when joining copper to copper.

Remember — a little time spent in hand cleaning of the parts to be soldered is still the only guarantee of a solid job that will stand up under pressure and vibration.

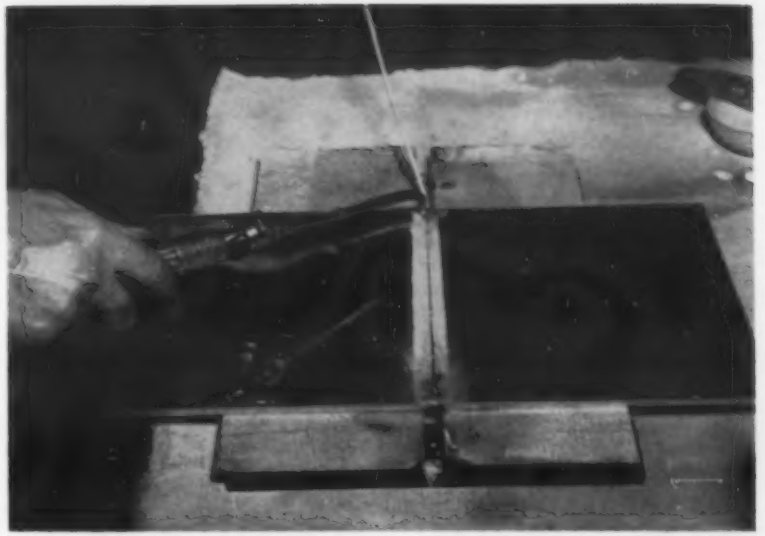
#### Brass Welding Technique

Experienced welders find that it is often preferable to braze rather than to weld brass parts. When the oxyacetylene torch is used for brass, adjust the flame





fold along this line—outside edges toward you



Close-up of low temperature welding with aluminum, showing how rod is melted to fill in "V" of edges

until there is a single cone such as you would need for steel welding. Keep the point of the flame slightly away from the weld, according to the thickness of the piece, so that the heat will not be sufficient to burn out the copper in the brass or volatilize the zinc. If a white smoke appears, remove the flame, as this indicates excessive heat. A little borax should be used as a flux. For brass welding it is advisable to use a tip larger than for the same thickness of steel. As a weld is really cast brass, it will not have the strength of rolled sheet brass. The fumes liberated from brass welding operations are highly toxic, hence ventilation at point of operations is a must.

#### Torch Welding Aluminum

Many maintenance men shy away from attempting to weld aluminum, because they have had a series of misfortunes with the work in the past. The fact is that the process only seems tricky. Actually, the welding can be done successfully every time if one thought is kept in mind — aluminum welded the usual way requires fusion heat of 1218 F. At this temperature the base metal at the point to be welded has an unfortunate habit of melting away.

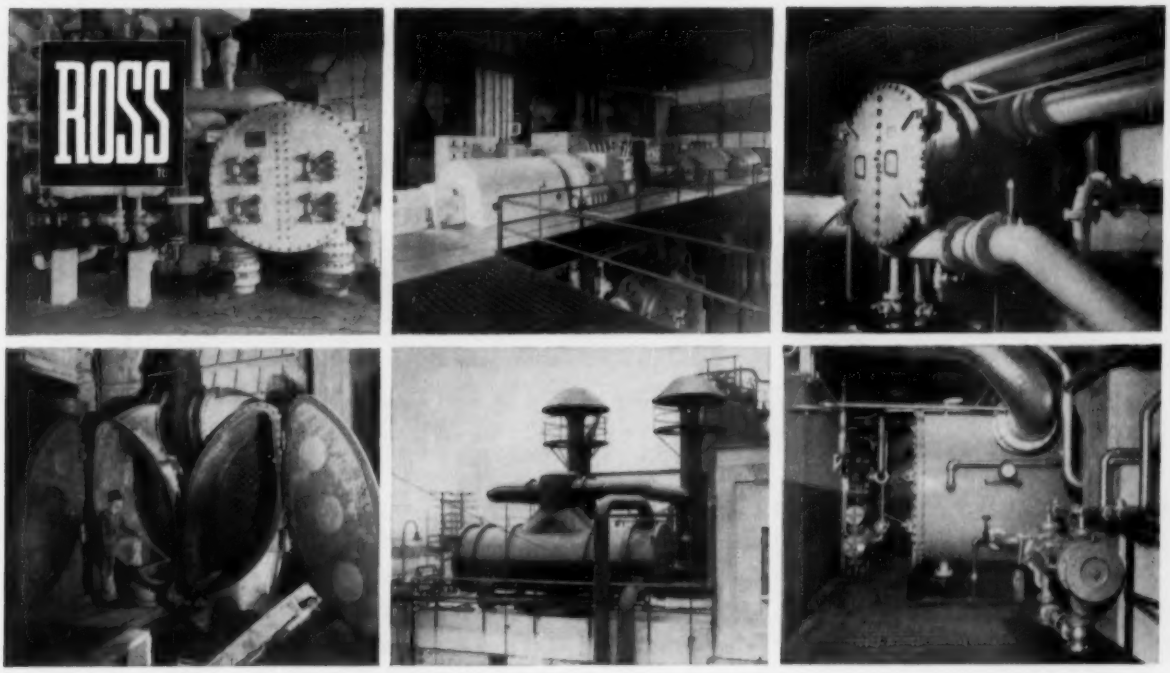
But the secret is that one can perform equally good work on aluminum by low temperature welding. Apply liberal quantities of flux (calcium chloride serves in a pinch) about the joint to be welded, then apply the flame *around* the weld area, not *on* it. The flux will serve as your thermometer to tell you when to apply the welding rod to begin making the weld. The flux melts at 950 F — quite a temperature reduction from the troublesome 1218 F.

With a little experience you will find that it is not necessary to move the weld rod around the joint to make a smooth, durable weld. The capillary attraction of the new metal being added from the weld rod to the parent metal causes it to flow beautifully, with only slight urging with the tip of the flame. The surface tension common to heated aluminum causes the weld metal to form a smooth, uniform bead over the whole joint.

A hydrogen flame will serve as well as one produced by oxyacetylene.



cut along this line

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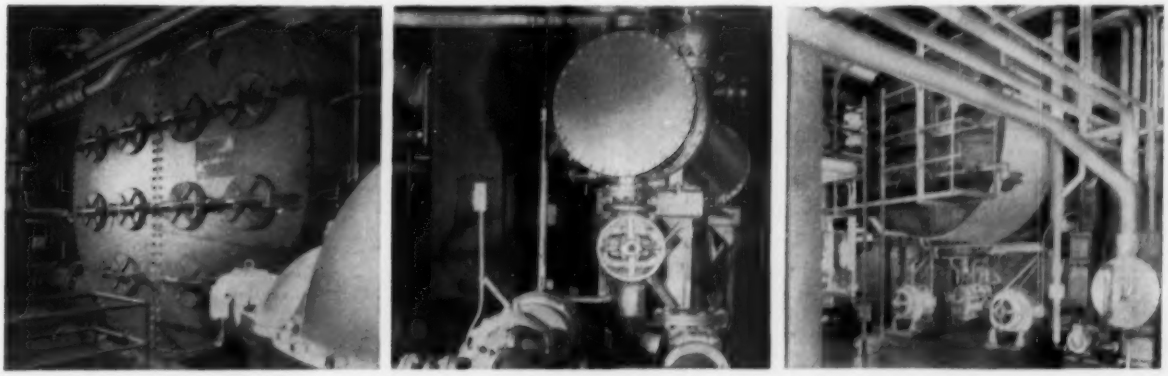

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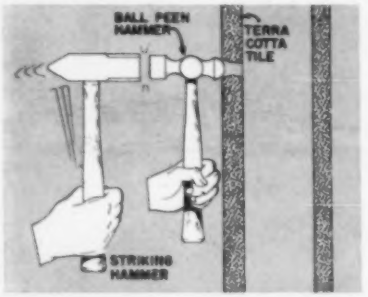
# How To Do It Better— A Shopwork Memo

By J. K. PAUL

DEVELOPING HOLES in terra cotta tile can prove a rather vexing project, as many a maintenance and construction man has discovered. The stuff is both glass-hard and fragile, so that no matter what type of hole developer is used, there is always a grave hazard of breaking out much more material than was originally intended to produce the hole for the toggle bolt.

The varying brittleness or hardness of one tile block over another is said to be due to the position that the tile occupied in the stack when burned in the kiln. A carbide-tipped rotary drill was usually found to be more successful in producing a reasonably round hole than was a percussion-type drill.

It took a carpenter's idle prank to demonstrate a very simple and effective trick that can be used to produce perfect round holes of any average size in a terra cotta tile. He was idly striking the face of a ball peen hammer with a second hammer as the ball rested against the tile wall of an abandoned building. Imagine everyone's surprise when the tile behind the ball peen hammer suddenly gave way to the impact of the ball and a round hole of the same size as the ball was produced.




Ball peen hammer is struck with second hammer, producing round hole the same size as the ball

Other carpenters (it was their lunch period) tried the stunt and they, too, produced perfect holes with just one blow of one hammer impinging on the face of a second hammer whose ball was in contact with the tile wall.

Try this sometime. You'll be amazed at the ease with which you can produce just the right-sized hole in the right spot, every time.

### Cementing Emery Cloth to Lapping Wheels

Heat created by friction as materials are dressed on emery-coated lapping wheels is quite destructive to the cement used for the fastening.

There is, however, a very effective adhesive that can readily be prepared in the work shop with simple ingredients. Use 4½ lb of powdered resin (block material will do as second choice but takes longer to melt down) and 4 lb of paraffin. Then heat the ingredients in a double boiler to prevent direct contact with high-heat surfaces. Stir well to insure complete amalgamation.

Clean the surface of the wheel well, to develop a good bonding surface. Then heat the area to drive off all the moisture. Apply the cement evenly, then the emery cloth, and rub down gently with round object to exclude all air which would otherwise cause incomplete adhesion.

### Eliminating Expansion Bolt Craters

Every plant equipped with concrete floors is pock-marked sooner or later with a series of cinch anchor craters left when machinery or walls are moved to make way for a change in the equipment layout. Any attempt to chip out the old anchor to produce a neat hole that could be patched with a neat concrete plug usually results in early failure, especially if wheel traffic prevails at that point in the plant.

Reason the plug failed to hold in the crater is found in the geometry of the hole — its tapered sides just don't have the right angle for gripping the concrete well. Consequently, any heavy movement over the spot loosens the plug, and the work has to be repeated many times.

To produce a vertical-sided hole, use rotary-type carbide-tipped drills of ample diameters, to encompass the whole crater and thus produce a cylindrical hole of the desired depth in the concrete floor. Most of the drills used for this purpose are of 2½-in. diameter, hence the shank is ½ in. A drill motor having a chuck of that same capacity was used to drive the drill. Two men worked the job, each man sitting on the handle of the motor to force the drill into the concrete with more force than would have been possible otherwise. Ample application of water kept the dust down and produced a cool drill.

With the hole still wet, a third man troweled in a quantity of neat cement and finished it off smooth with the old floor surface. Each patch was then wetted down at 3-hour intervals for the next 24 hours to insure thorough hardening of the new concrete. The patches are as durable as the original floor. (You can use one of the special floor-repairing cements for this purpose if you have it.)



fold along this line—outside edges toward you

# Attachment for a Square

By F. E. RILEY

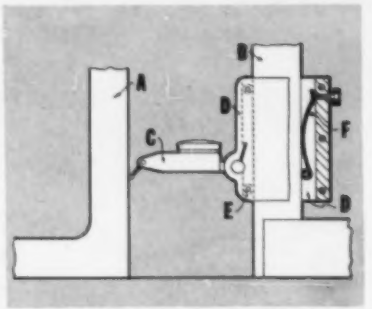
GAGING THE SQUARENESS of a face A by means of the normal square B can give rise to a lot of argument, particularly between inspectors and machine operators. The inspector is experienced in the detection of light gaps between square blade edge and the work surface, and some can gage the exact width of the gap by observing the color of the light. Machine operators are not usually so skilled in the art of calculating light gaps, and some more positive form of assessment is necessary.

Such an indicator of accuracy is the small type of dial indicator shown at C. The indicator is mounted on a small carriage which can slide vertically on the edge of the square blade and indicates positively the quality of the alignment between the work face and the blade.

The attachment comprises a pair of aluminum cheek plates, D, placed on either side of the square blade, with a pair of rollers, E, placed at the upper and lower ends of the plates. The rollers are made with short stub axles protruding from each end and are machined at one setting to obtain concentricity. The dial indicator is gripped in a swiveling mounting so that it can be arranged to point downward and the feeler brought within close proximity of surface plate.

A resilient sliding contact point at the rear of the attachment is provided by the leaf spring F which is anchored at one end and provided with a pressure-adjusting screw at the other. The attachment is maintained in position on the square blade by the friction obtained from the spring, but where the attachment and dial indicator are too heavy to allow this, a positive lock can be provided by screwing the adjusting screw until its end forces the spring into contact with the back of the blade.

Frictional hold of the attachment on the blade can be increased by eliminating the two rollers, and providing instead, two fixed sliding surfaces. This should be adopted where possible, since elimination of the rollers removes one possible source of errors and simplifies construction of the tool.




Dial indicator shown at C is mounted on a small carriage sliding vertically on blade of square



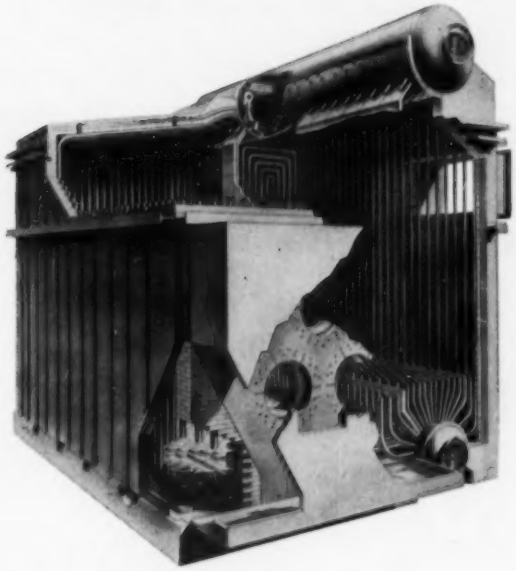
cut along this line

Here's why you get

# IMPORTANT SAVINGS in

- ✔ *first cost*
- ✔ *installation*
- ✔ *operation*
- ✔ *maintenance*

with the FW Series "SC" STANDARD BOILER



THESE nine Foster Wheeler design features add up to substantial savings in the cost of steam generation. Equally important is the extra *dependability* that's built into every "SC" unit – the result of over 60 years of experience in the design and construction of large, high-pressure steam generators for leading central station power plants.

Pre-engineered in all details and standardized for economy, these FW standard steam generators are available for oil or gas firing, in capacities from 50,000 to 150,000 lb/hr, for pressures to 1500 psi and superheated steam temperatures to 950 F. For complete information, send for Bulletin B-55-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

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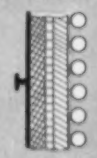
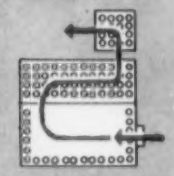
**1. COMPLETELY WATER-COOLED WALLS**

All furnace walls are cooled by closely-spaced tubes, minimizing setting maintenance and preventing excessive exit gas temperatures.



**2. EFFICIENT FIRING ARRANGEMENT**

Burner arrangement assures maximum rating without overheating furnace tubes. Rear wall is over 19 ft. from burner wall, permitting long, horizontal flame travel.



**3. FULLY DRAINABLE SUPERHEATER**

A completely drainable superheater permits removal of all condensed water from the elements before start-up.

**4. HIGH STEAM PURITY**

The normal drum internals consist of chevron dryers and a dry box. Separators may be added which make possible a steam purity of 1PPM or less.

**5. UNRESTRICTED CIRCULATION**

Absence of headers provides free circulation through integral risers and downcomers, eliminating header handhole plates and gaskets.

**6. BOTTOM SUPPORTED UNIT**

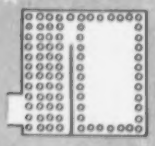
The bottom-supported design fully utilizes the structural strength of the tubes and provides low unit stresses in all members.

**7. PRESSURE-TIGHT CASING**

The all-welded casing forms a rigid, pressure-tight unit that can be arranged for pressurized or balanced draft operation.

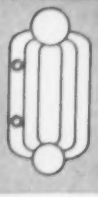
**8. MINIMUM REFRACTORY BAFFLING**

The wall separating furnace and boiler bank is the only refractory baffling used. It is completely accessible from the furnace.



**9. SIMPLE SOOT BLOWER ARRANGEMENT**

Soot blowers are supported on the outer row of boiler-bank tubes, simplifying alignment and providing easy access.



For more data circle 546 on Post Card

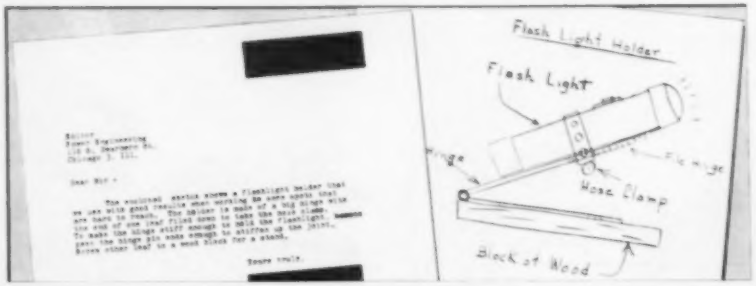
# Your Ideas Are Worth Money to You

YES, YOUR IDEAS are worth money to you — but not if you keep them to yourself. If you have developed a practical and ingenious tool, method, or process that can be of help to others in the power field, send it to the Handbook Editor. POWER ENGINEERING pays you $5 to $25 for each idea that is published; amount we pay depends solely on importance of the published item.

We know that many engineers and operators in the power field are daily using their own ideas to perform jobs more efficiently; we also know that these men often fail to send in their ideas because they think they lack the necessary literary or artistic skill to present them to us. Don't let this discourage *you*.

To show you what we mean, an actual case history is reproduced below (contributor's name withheld). Easy? Sure it is. Let's hear from you.

## If You Can Provide Us With This . . . .

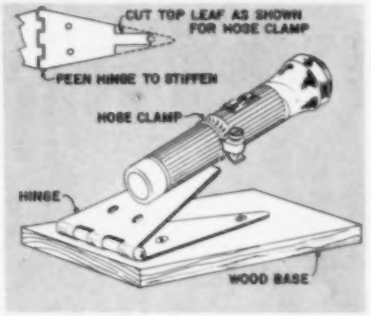



## We Can Publish It Like This . . . . . .

**By JOHN DOE**

If you have ever wished for another hand so you could work with two and hold a flashlight with the third, this handy adjustable stand may be the answer. It consists simply of a long hinge, hose clamp, and block of wood.

Only work necessary to make stand is to cut or file upper leaf — as shown in drawing — and to tighten hinge to hold stand in position. Hinge action can be stiffened by peening with a hammer. If desired, solder hose clamp to underside of hinge tongue to retain it in place when flashlight is detached.




POWER ENGINEERING HANDBOOK

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# Pump Maintenance Records Pay Dividends

TOO OFTEN plant records of pumps are little more than an inventory record for accounting and insurance purposes, listing pump size and manufacturer. In other plants, maintenance records may be kept as part of a pump lubrication schedule. In either case complete pump records could be kept with little additional effort.

Complete maintenance records, filed in an accessible location, are invaluable in diagnosing pump failure, in ordering repair parts, in establishing lubrication and maintenance scheduling. In addition, these maintenance record cards are valuable in determining pump suitability for new requirements due to process changes. Notations of pump failures and the repairs required can be used to define the optimum period of any given pump before complete inspection and overhaul is required.

If the pump maintenance records indicate that no failures have occurred over a period of years, a longer period between inspections would be warranted. On other pumps, the records may indicate frequent failures. This may suggest that semi-annual inspection and repair are required. It should also flash a red warning light — something is wrong with the pump, either in application, installation or operation. A chronological listing of failures is invaluable in diagnosing the problem and effecting its cure. Simple maintenance records for each pump, in both primary and secondary service, are much less expensive than trial and error solutions.

Notations of pump repairs can be used to develop proper spare parts inventory. Frequent replacement of parts subject to wear may indicate a different material would be more economical.

To aid power engineers and any others whose operations involve the use of many pumps, Goulds has designed a pump maintenance record card, reproduced from *Goulds News*, which provides for complete information on installation, application and maintenance. Space is provided on each card, using both sides, to keep a complete record for a period of years — in some cases for the entire life of the pump.

A supply of these cards will be sent to those who write the Editor. Please indicate the number of pumps you have.

PUMP NO. _____ LOCATION _____ DATE INSTALLED _____

| | | | | | |
|---|---|---|---|---|---|
| Service | Primary ☐ Secondary ☐ | Mfg. | Construction | GPM | |
| Driver No. | | Ser. No. | Casing | Head | |
| H. P. | | Fig. No. | Impeller | Liquid | |
| RPM | | Size | Shaft | Sp. Gr. | |
| | | Imp. Dia. | Sleeves | Temp. | |
| | | Rotation | Seals | NPSH | |

MAINTENANCE RECORD

| Date | Reason for Maintenance | Parts Replaced |
|---|---|---|
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POWER ENGINEERING HANDBOOK



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# MARLEY IS STILL TESTING TOWERS

Here are the current results—a consecutive list of **ALL** acceptance tests conducted by Marley during 1956 on Cross-Flow industrial towers. Although towers tested were of many sizes and capacities, operating under varying conditions and in various parts of the country, there is one "common denominator" in all the tests—the positive performance of Marley cooling towers. Better than words, better even than written guarantees, these tests are your assurance of complete performance satisfaction when you purchase a Marley cooling tower.

The Marley Company has long pioneered the policy of "test your tower," for we believe that every purchaser is entitled—if not obligated—to know the performance of his tower in exact and authoritative terms. We also believe that every prospective purchaser is entitled to know the performance record of Marley towers, and for this reason have consistently published the results of Marley's own tower-testing program.

If you'd like to know the Marley method of measuring performance of cooling towers, regardless of make or vintage, we invite you to write for our technical publication, "TEST YOUR TOWER."

| TEST NO. | TYPE OF SERVICE AND LOCATION | SPECIFIED CONDITIONS | | | | TEST RESULTS | |
|---|---|---|---|---|---|---|---|
| | | Gallons Per Minute | Hot Water Temp. | Cold Water Temp. | Wet Bulb Temp. | Degrees Cold Water Temp. | Percent Capacity |
| 1 | Generating Station—North Central | 49,200 | 100.8° | 85° | 74° | +.26° | +2.3% |
| 2 | Generating Station—Southwest | 28,000 | 99.5° | 83° | 74° | +.15° | +1.5% |
| 3 | Chemical Plant—East Coast | 33,000 | 105° | 86° | 81° | +.43° | +12.7% |
| 4 | Generating Station—Mid-West | 62,400 | 107.5° | 90° | 76° | +.02° | +.13% |
| ★5 | Petrochemical Plant—Mid-West | 10,000 | 105° | 83° | 76° | —.25° | —2.14% |
| 6 | Petroleum Refinery—Mid-West | 8,500 | 120° | 85° | 76° | +.15° | +1.35% |
| 7 | Generating Station—Mid-West | 26,000 | 110° | 91° | 75° | +.70° | +3.4% |
| ★8 | Petroleum Refinery—Gulf Coast | 21,000 | 113° | 90° | 80° | —.45° | —2.85% |
| 9 | Petrochemical Plant—Gulf Coast | 6,000 | 105° | 85° | 80° | +.06° | +.69% |
| 10 | Petrochemical Plant—East Central | 21,000 | 120° | 85° | 73° | —.2° | —1.5% |
| 11 | Generating Station—Southwest | 38,700 | 93° | 78.5° | 65° | —.4° | —2.15% |
| ★12 | Generating Station—North Central | 7,180 | 101° | 87° | 74° | +.1° | +.77% |
| 13 | Generating Station—East Coast | 26,400 | 96° | 86° | 79° | +.30° | +4.17% |
| 14 | Petroleum Refinery—Mid-West | 8,000 | 120° | 84° | 74° | +.70° | +6.4% |

★ Tested in accordance with Cooling Tower Institute test procedure ATP-105 and observed by CTI representative.

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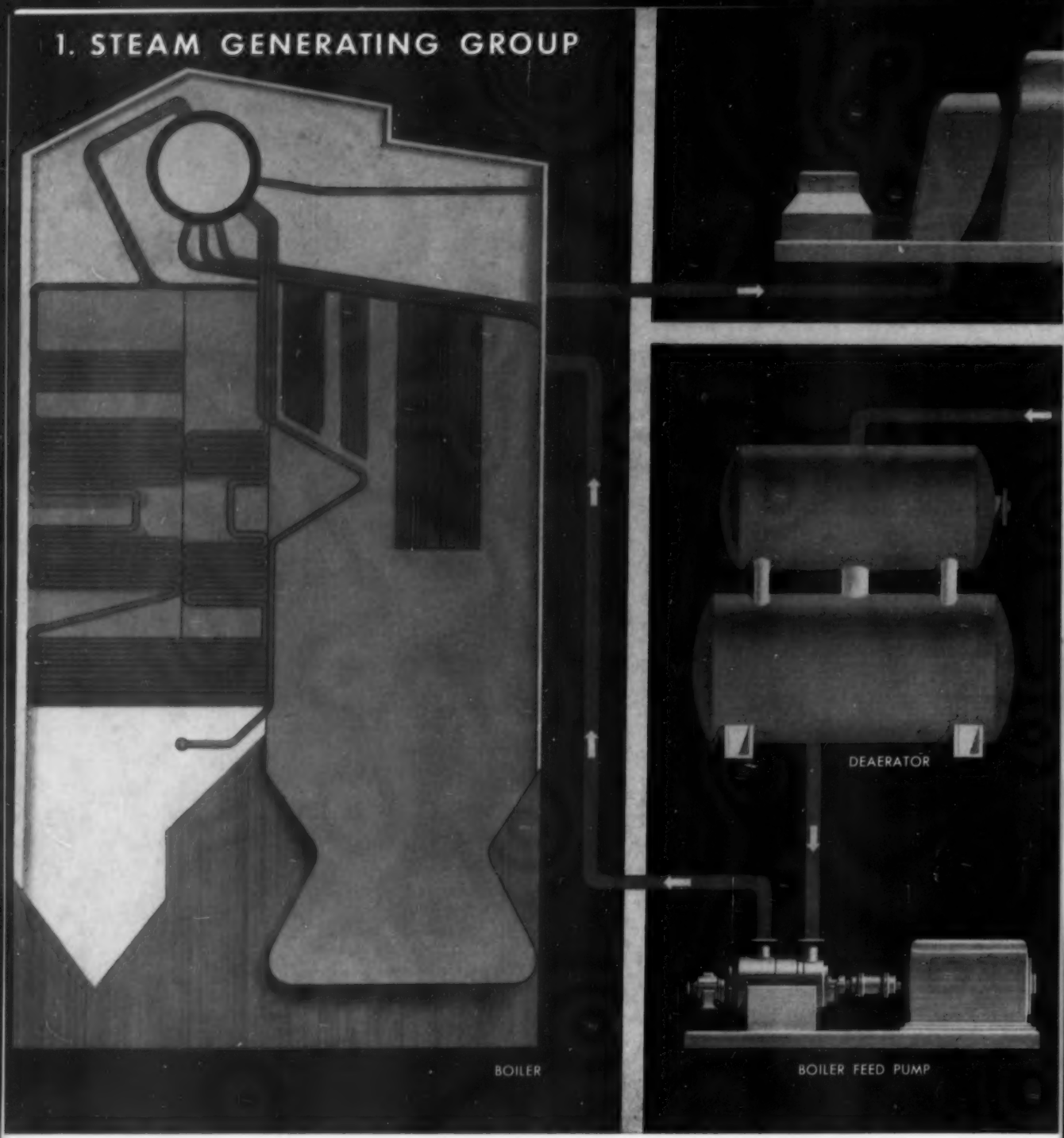
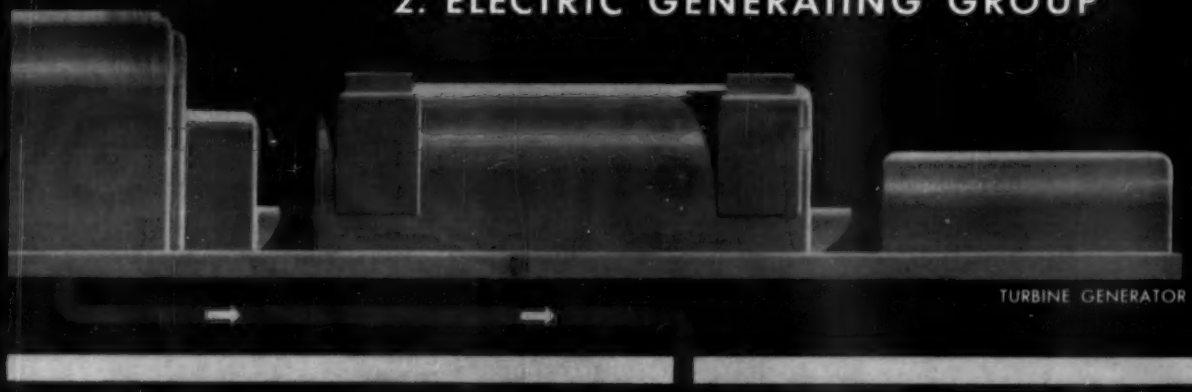



# Look at all three

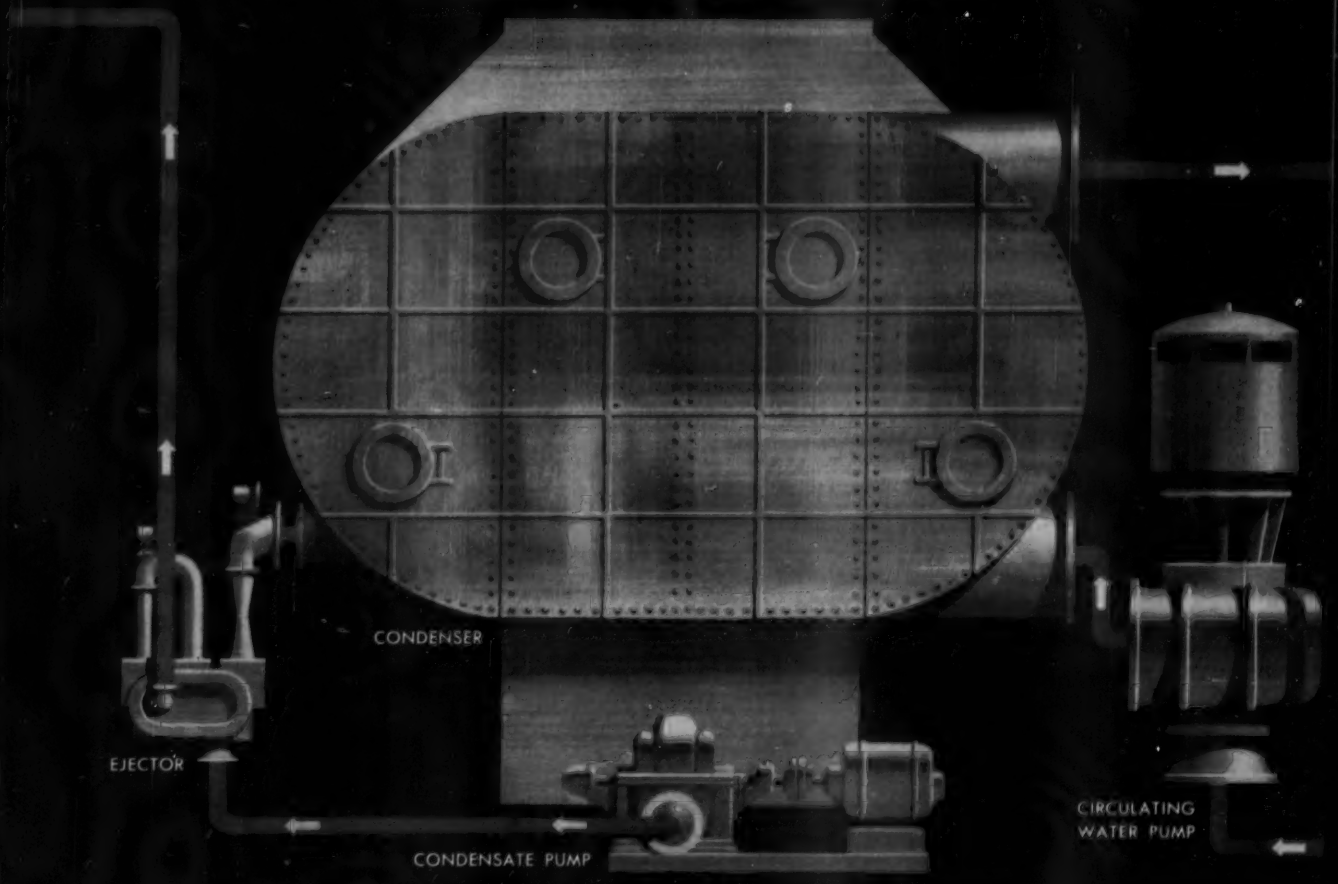
A new steam station design approach is bringing higher efficiencies, lower costs, and greater reliability. In this approach, only three basic functions are considered: (1) Steam Generating, (2) Electric Generating, (3) Fluid Handling. Station requirements are first analyzed in terms of the over-all job performed by each of these groups rather than by each individual piece of equipment.

Many of the benefits of this approach occur in the Fluid Handling Group. Here coordination and integration of the wide variety of equipment used can often effect substantial improvement in over-all operation. As steam temperatures and pressures go up, there are increased demands on the fluid handling function. Plant reliability often depends on the effect of one component of the fluid handling group on another during operational transients, either planned or of emergency nature. The solution is coordinated equipment

## 2. ELECTRIC GENERATING GROUP




## 3. FLUID HANDLING GROUP

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selection, engineering and design. And Worthington's "system" know-how and experience with modern complex plant cycles can help solve your fluid handling problems.

**System-wise experience** As the manufacturer of all major components of the Fluid Handling Group, Worthington has a reservoir of experience and knowledge that can be of benefit to you. To put this "system-wise" experience to work for you, get in touch with your nearest district office. Or write to section C-71, Worthington Corporation, Harrison, New Jersey.

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## Power Conference

*continued from page 75*

to a 450-mw turbine generator unit.

In the immediate future, Wilson said, the maximum economic steam conditions probably will be 3500 psi pressure and 1050 F temperature, and advances in these will depend almost entirely upon the development of better high temperature alloys.

As for the immediate present, the majority of the new large boiler units ordered in 1956 were designed to deliver about 1,200,000 lb of steam per hour and will serve turbines rated at about 150,000 kw and designed for 1800 psi and 1000 F temperature steam with reheating to 1000 F.

Turning to the steam-gas turbine cycle, Wilson said that a substantial gain in cycle efficiency, in the order of 5 to 7 per cent as compared to the straight steam cycle, can be attained by combining the gas turbine and steam cycles.

### Space Heating

Discussing the place of the heat pump and solar energy in space conditioning, R. C. Jordan, head of mechanical engineering at the University of Minnesota, reported that by early 1956 there were about 8000 residential and commercial heat pump systems in this country, about half of these being in the gulf states area.

Jordan emphasized that heat pump systems have emerged from the status of experimental curiosities to that of practical devices. Reason: the changing relative costs of fuels and the growing acceptance of comfort air conditioning.

Air and water are the two primary heat sources for current heat pump systems. For both residential and commercial installations, the use of air as a heat source is now predominant.

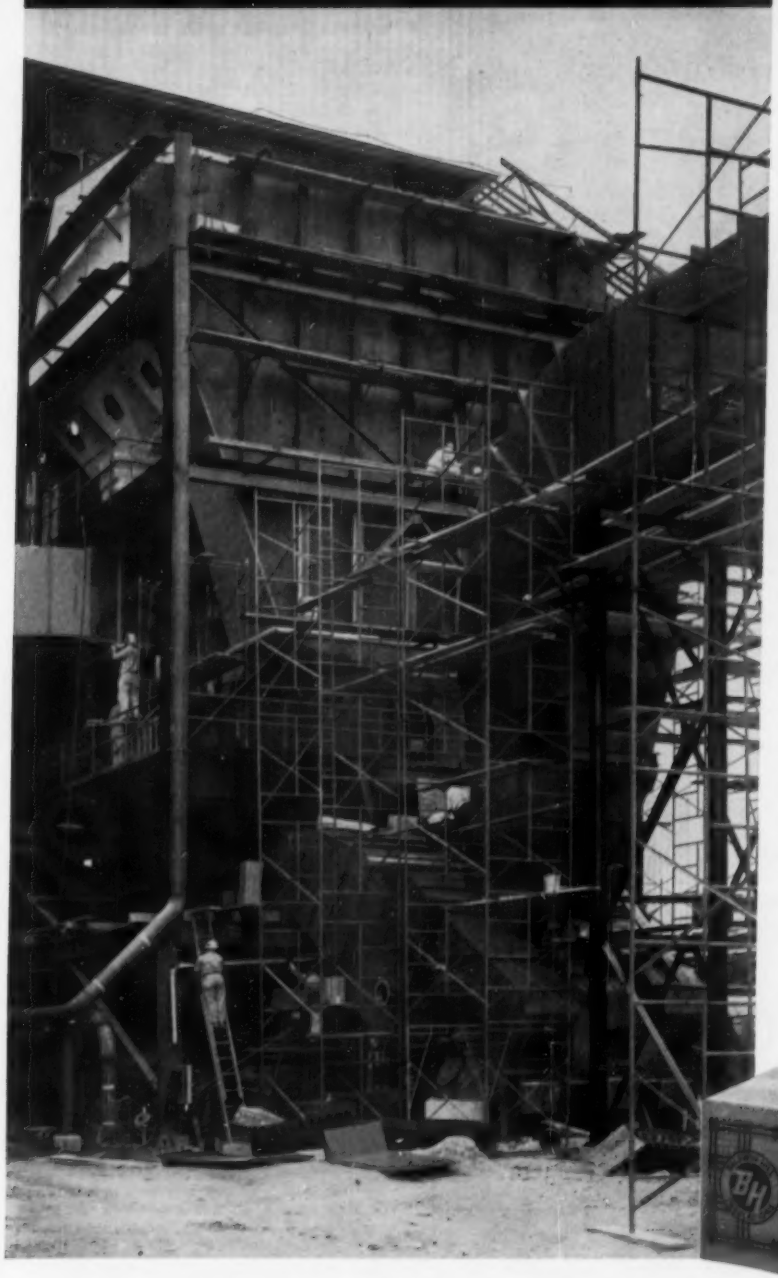
Solar heating systems are further away from technical perfection and public acceptance. However, solar energy is capable of supplying all of the heating needs in mild climates possessing reasonable solar availability, Jordan said. One of the interesting near-future possibilities appears to be in the adaptation of solar energy as a heat-pump source, either partial or total.

Jordan singled out two outstanding installations for description. One was the heat pump system — the world's largest — for the new Southdale Regional Shopping Center near Minneapolis. Here, over half a million dollars was saved in initial costs by the use of a heat pump system for space conditioning.

Second installation was for the Bridgers and Paxton office building in Albuquerque, N. M. This is a completely solar heated building, the first of its kind. A gross area of 4300 sq ft is served by 830 sq ft of solar

*continued on page 108*

# 500,000 lb. per hr. BOILERS at New DELAWARE CITY STATION



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MONO-BLOCK, made of spun mineral wool, is effective over the full temperature range to 1700° F. It was used to cover all flat and large curved surfaces of boiler walls, accessory housings and ducts. Light in weight, rigid and easy to handle, MONO-BLOCK is quickly applied.

Baldwin-Hill SUPER POWER-HOUSE CEMENT was used to point all joints and as a one-coat insulating-finishing cement.

See our catalog in Sweet's Plant Engineering File.

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## Power Conference

*continued from page 106*

collector surface, or a ratio of floor area to collector area of slightly over 5 to 1. Thermal storage is provided by a 6000-gal water tank installed underground. Outdoor air for ventilation is supplied through a central system with the air tempered in winter and cooled in summer. A 7½-ton refrigeration unit aids heating in winter and cooling in summer.

Looking ahead, Jordan sees fantastic world energy demands posed against the limited supply of stored energy sources, particularly of oil and gas fossil fuels. This, he thinks, will probably make necessary the conversion of coal to fluid fuels within a decade or so. Because of its vast potentialities, solar energy's ultimate utilization in large scale is assured, Jordan said, and one of its most probable near future uses in this country will be in space conditioning.

### Hydroelectric

Walter Dreyer, chief engineer of Pacific Gas & Electric Co, traced the history of the tying together of hydro and steam plants in northern and central California, a story which goes back almost 60 years. It demonstrates (1) that this kind of "mingled power" results in taking advantage of the diversity which exists in stream flow at different hydroelectric plants; (2) that steam generated power can be combined with hydro power to furnish continuous and reliable service; (3) that pooling of a widely varying regional demand can result in economy because less capacity is required to be installed to meet demands.

The company now has 13 steam-electric plants and 58 hydroelectric plants, with a total capacity of 4,528,000 kw, plus some 500,000 kw from other agencies. The 1956 peak demand on the system exceeded 4,100,000 kw, and during the year some 18,400,000,000 kwh were delivered to consumers.

Dreyer's charts and figures showed that a combination of low-capacity factor hydro., i.e. "peaking hydro," and "higher than system load factor" steam can produce economic results. He made the point that in planning hydroelectric development, it may be short-sighted to keep capital costs down by designing the facilities for high load factor operation. If reasonably possible, the way should be kept open for future expansion in order to obtain the maximum benefit from development of the hydroelectric potential.

In order to make the full installed capacity effective, it is essential that the hydro plants be planned so they can generate enough power under conditions of adverse water supply to meet the energy requirements of that portion of the peak load assigned to the hydro plant.

It is equally important that the amount of the peak load assigned to the hydro plants must not be so large that in dry years it will require the steam plants to operate at capacity factors beyond their reasonable ability; that is, not in excess of 90 per cent in any month, or at an annual capacity factor in excess of 80 per cent.

It is expected that nuclear plants will be capable of economic operation at high capacity factor, so they should be a new and welcome ally in the field of integrating hydro and thermal power.

### Fuels

The session on fuels drew an overflow crowd, under the chairmanship of Martin A. Elliott, director of IIT's Institute of Gas Technology. Clarence A. Dauber, director of civil and mechanical engineering for Cleveland Electric Illuminating Co, led off with a discussion of a pipe line transportation of coal.

Describing the pipe line as a major factor in serving electric customers with better service cheaper, Dauber said that 1957 will see the first commercial movement of coal over a long distance by these means.

Dauber described in detail the 108-mile line between the Georgetown, Ohio coal preparation plant of Pittsburgh Consolidation Coal Co., and the utility's Eastlake plant. (See POWER ENGINEERING, October 1956.) An estimated 1,250,000 tons of coal will be delivered annually by this pipe line.

Under the Pittsburgh-Cleveland arrangement, the shipper is assured of a customer for a definite tonnage for a long period, an advantage in planning mining operations. A disadvantage to the supplier, Dauber said, is that the shipper is furnishing a single source with a large portion of his product.

In calculating what the cost would be to ship coal by pipe line, 15-year amortization was used. All the factors such as cost of money, taxes, insurance, are fully charged. Use factor for the system is expected to be at least 90 per cent. Net result, Dauber reported, was a substantial savings when compared with the present railroad tariff of over $3.30 per ton from the Georgetown cleaning plant to the Eastlake power plant.

Dauber's conclusion was that although the transportation of coal by pipe line will be expanded in future, it will not serve all requirements. The conditions must be ideal in order to be competitive.

George A. Lamb, manager of business surveys for the Pittsburgh Consolidation Coal Co, followed Dauber with a paper on the bituminous coal market in the immediate future.

Lamb reported that electric utilities increased their bituminous consumption 40 million tons — 35 per cent — in the last two years. Bituminous coal now supplies the fuel


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## Power Conference

*continued from page 109*

energy for 70 per cent of the power generation by the utility steam plants. It took 0.94 lb of coal to produce a kwh in 1956. This burning rate has been reduced continually through plant advancements over the past year, and will be reduced still further, probably to as low as 0.85 lb within the next five years.

Coal's share of steam generation has advanced from 65 to 70 per cent since 1954, Lamb said, since residual oil and gas have become less abundant and higher priced for boiler fuel purposes. Bituminous coal production reached the half-billion level in 1956 for the first time since 1951.

Projecting bituminous coal consumption to 1961, in million tons, Lamb came up with these figures: for electric utilities, 198 (155 in '56); steel and coke, 115 (111 in '56); railroad and other industrial (retail), 167 (167 in '56). This makes a total of 480 million tons predicted for 1961, as compared with the 433 million tons consumed in 1956.

## NEW ENGINEERING BOOKS

**Introduction to Solid State Physics,** by Charles Kittel. Second Edition, 1956. 617 pages, 9¼ by 6 in., cloth. Published by John Wiley & Sons, 440 Fourth Avenue, New York 16, N. Y. Price $12.00.

This volume is intended as an introductory text book in solid state physics for students of physics, chemistry, and engineering. It is for graduate students, the level of presentation being such that the reader needs to have a good general familiarity with modern atomic physics up to the level of the undergraduate courses offered under this title in many universities. A course in quantum mechanics is not necessary for the understanding of most books but the reader should be familiar with the Planck radiation law, the de Broglie relation, the Bohr theory of the hydrogen atom, the Zeeman Effect and the wave equation for free particles.

In this book the physics and chemistry of solids are described. The following subjects are covered: description of crystal structures; diffraction of X-rays by crystals; classification of solids and lattice energy of ionic crystals; elastic constants of crystals; lattice vibration; thermal properties of solids; dielectric properties; ferro-electric crystals; diamagnetism and paramagnetism; free electron model of metals; band theory of solids; Brillouin zones; semi-conductor crystals;

superconductivity; photoconductivity and luminescence; and dislocations.

The book treats these subjects extremely thoroughly and for those interested in solid state physics and possessing adequate technical background, it is an excellent volume.

This is the second edition of an original work and it is almost twice as large as the first edition with all chapters amplified in considerable detail.

* * *

**Reactors,** edited by R. A. Charpie, D. J. Hughes, D. J. Littler and M. Trocheris. First Edition, 492 pages, 6½ by 9¼ in., cloth. Published by McGraw-Hill Book Co, Inc, 330 W. 42nd St, New York, N. Y., 1956. Price $14.00

This volume is the second of a series of 8 entitled Progress in Nuclear Science being published by the McGraw-Hill Book Co. As indicated in a foreword by Dr. L. R. Hafstad, former Director of the AEC's Reactor Division, this volume is the tangible symbol of a historic milestone in the international advance of science. It presents a series of review papers on the present state of the reactor art.

Included are surveys of the design and operating characteristics of the important research reactors throughout the world including the Soviet Union. The summaries by acknowledged experts in the field enables one to compare in detail the state of the nuclear power art in various portions of the world. Every reactor project is represented in this volume and the surveys have been enlarged to include all the information presented at the Geneva Conference.

* * *

**Handbook for Small Sawmill Operators,** prepared by Logging and Milling Committee of Forest Products Research Society. Size 5½ by 8½, 62 pages, paper binding. Published by The American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y. Price $3.00.

This new handbook is designed to help operators of small sawmills produce more and better finished lumber from a given quantity of logs. It is divided into four chapters: Machinery, Saws, Mill Setup, Operation and Trouble-Shooting. Each of the chapters contains specific recommendations and suggested procedures for improving performance in relation to the central theme of the book, "How to attain and maintain accuracy of cutting."

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## BOILERS, GENERATORS

**201 Water Tube Boilers** — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

**202 Shop Assembled Boiler** — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM watertube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

**203 Automatic Boilers** — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air through static, turbine-like vanes into burner. Boiler Engineering & Supply Co., Inc.

**204 Hot Water Boilers** — This 20-pp brochure describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications. Combustion Engineering, Inc.

**205 Steam Generators** — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

**206 Improved Steam Generator** — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

**207 Standard Generators** — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of the units and illustrations of design features are included. Foster Wheeler Corp.


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**208** **Packaged Generators** — Bulletin MH 3–54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

## COAL, ASH HANDLING

**210** **Tractor Shovel** — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog M8-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

**211** **Coal Crusher** — Company's WC and W8 series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

**213** **Spreader Stoker** — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lbs of steam per hour. Detroit Stoker Co.

## REFRACTORIES, INSULATIONS

**215** **Refractory Concrete** — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

**216** **Refractory Cement** — Heavy duty brick bonding and patching mortar is described in this 8-p illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

**217** **Refractory Castable** — Bulletin R-40 describes use of Kaocrete-32, a high temperature refractory castable, in boiler ashpits. A discussion of various methods of ash removal, along with maintenance problems peculiar to each, is presented. Four typical installations are detailed. Refractories Div., The Babcock & Wilcox Co.

## WATER CONDITIONING

**218** **Water Conditioning Data Book** — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water

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**219 Feed Water Heaters** — Bulletin S-217, 6 pp, describes company's baffle spray type deaerating feed water heater. Tells what it is and what it does, describes design and operation features, as well as applications and capacities. A cutaway view shows component equipment and construction. Stickle Steam Specialties Co.

**220 pH and Chlorine Control** — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers. W. A. Taylor Co.

**221 Ion Exchangers** — Sixteen-pp Bulletin 1960-C, on ion exchangers, discusses the principles of cation and of anion exchange, and the practical operation of ion exchangers. General properties of company's ion exchange materials are given. A chapter is devoted to design features of manufacturer's ion exchange equipment. Installations are illustrated. Infilco Inc.

**222 Deaeration Literature** — The facts about deaeration are thoroughly reviewed in a series of bulletins available from the company. What deaeration is, why it is necessary, and types of deaerators are among the subjects covered in one of the bulletins. Others in the series describe various types of deaeration equipment, including the Jet-Tray deaerator, tray-type deaerators, cold water deaerators, a surface type deaerating hot water heater, boiler feedwater deaerating heater, and atomizing deaerators. Cochrane Corp.

**223 Feedwater Treatment** — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. National Aluminate Corp.

**224 Carbon Dioxide Measurement** — Technical Paper 133, 16-pp, discusses determination of $CO_2$ in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

**225 Water Treatment** — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

**226 On Demineralization** — Technical Reprint T-140, 23-pp, a profusely illustrated article on demineralization, discusses advantages and disadvantages of this process for today's power plants. Developments, trends and applications of both multi-bed and mixed-bed ion exchange are considered, and several case histories cited. A comprehensive bibliography lists 119 separate items. Tables, flow sheets, descriptive drawings, performance curves, process selection charts included. Graver Water Conditioning Co.

**227 For Boiler Protection** — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine, and properties and handling of the material. Comprehensive operating data are presented in the form of case studies. Olin Mathieson Chemical Corp.

**229 Feed Water Deoxygenation** — The advantages of chemical deoxygenation of boiler feed water with an aqueous solution of hydrazine are described in 12-pp Bulletin BW 5. How hydrazine serves to maintain boiler in cleanest possible condition, reducing iron oxide scale to a magnetic oxide, is fully detailed, and such considerations as economy and operation, handling precautions, storage are covered. Fairmount Chemical Co., Inc.

## TUBING AND ACCESSORIES

**231 Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.


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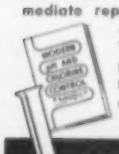

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830 ROGERS FORGE RD. • BALTIMORE 4, MD.


**233 Heat Exchanger Tubing** — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

**234 Tube Expanders** — Catalog 88, 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving sizes. Thomas C. Wilson, Inc.

## VALVES, TRAPS, PIPING AND ACCESSORIES

**235 Check Valves** — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

**236 Lubricated Plug Valves** — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

**237 General Purpose Valves** — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

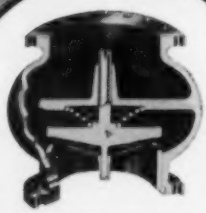
**238 Diaphragm Motor Valve** — Bulletin J-170 describes outstanding features of company's diaphragm motor valve designed for accurate control of pressure, temperature, rate of flow, and liquid level. Cutaway view showing component parts is included, along with data on materials of construction, capacity tables, and flow diagram. The Jordan Corp.

**239 Boiler Blow Off Valves** — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

**240 Regulating Valves** — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

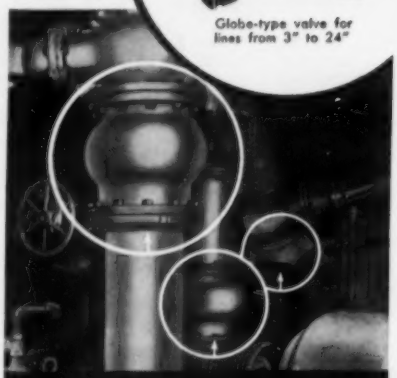

**Safe, Silent Piping Systems**

**for Pulp and Paper Mills**



Globe-type valve for lines from 3" to 24"

At Longview Fibre Company, Longview, Washington, valves installed in both vertical and angular positions.



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Systems processing ordinary water and black, green, white, pink and sulphite liquors are protected from water hammer damage by these *Silent* Check Valves. By closing instantly when flow reversal starts, or when flow is zero, they effectively control surge pressures.

*Write for Bulletins:*

**No. 654 on the Valves**

**No. 851 on Cause, Effect and Control of Water Hammer**

**THE WILLIAMS GAUGE CO., INC.**

143 Stanwix Street

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**241 Water Hammer Control** — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

**242 Valve Chart** — Form 194R, 22 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

**243 Bronze and Steel Valves** — Catalog 200, 80 pp, describes company's bronze and steel valves, including globe, angle, gate, Flocontrol and other types applicable to power, petroleum, chemical and general industry installations. Engineering data such as material specifications, flow charts, temperature and pressure ratings are included. The catalog is profusely illustrated with photos, cutaway views and dimensional drawings. Manning, Maxwell & Moore, Inc.

**244 Choosing the Right Valve** — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

**247 Valve Data** — This loose-leaf notebook contains a collection of company's bulletins on its line of valves for control of air, gas, liquids and solids. It features complete operating, design, dimensional and specification data on butterfly, slide, automatic and proportioning valves, and is profusely illustrated with photos, drawings and diagrams, highlighting valve design and construction. W. S. Rockwell Co.

**249 Industrial Valves** — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

**250 To Get at Those Valves** — This little folder describes a sprocker rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

**251 Steam Trap Book** — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment a maintenance section explaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

**252 Steam Trap Selector** — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

## INSULATION

**254 Duct Insulation** — Engineering data and application instructions for company's semi-rigid, spun mineral wool duct insulation are presented in this informative bulletin. Thermal and sound absorption characteristics are presented in tabular form and physical, chemical, mechanical properties given. Baldwin-Hill Co.

**255 Underground Pipe Insulation** — This illustrated bulletin discusses the problems of underground pipe insulation and explains how company's insulation for hot underground pipes overcomes them. On-the-job photos illustrate ease of application; brief technical data are also included. American Gilsonite Co.

## INSTRUMENTS, CONTROLS

**256 Boiler Feed Control** — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

**257 Instrument Panels** — Power and process plants can choose instrument


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Can be cleaned with soap and water or with mineral spirits or kerosene.

Highly resistant to abrasion and outdoor weathering.

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Drier air gives you better operation and lower costs in using all air-operated automatic instruments, tools and machines, paint spraying, sand blasting and moisture-free air cleaning.

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Niagara *Aero* After Cooler assures all these benefits because it cools compressed air or gas below the temperature of surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air through a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter, proven in service on the largest plant utility systems.

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and control panels to meet individual specifications from six standard designs described in 16-pp Product Specification G71-7. Complete specifications are furnished, as well as information on supports and mountings for tubes, wires and equipment, instrument mounting dimensions, and dimensions of standard instrument and control panels. Bailey Meter Co.

**259 Easy Reading Gage** — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

**260 Instruments, Controls** — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, $CO_2$ meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

**261 Solenoid Pilots** — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, gas and liquid service. Schematic diagrams of typical applications are given. Spence Engineering Co., Inc.

**262 Steam Calorimeter** — This bulletin discusses an improved U-path calorimeter combining a throttling, separating and re-evaporating calorimeter in a single chamber. Explains construction and operation of unit. Ellison Draft Gage Co., Inc.

**263 For Feedwater Analysis** — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

**265 D-C Amplifier** — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features, describes applications. Hagan Corp.

**266 Sampling System** — A newly developed system for continuous sampling and oxygen measurement of combustion processes is described in Bulletin 703. Points out advantages of system and diagrams component parts. Selection of sampling tube and gas selector units is discussed. Arnold O. Beckman, Inc.

**267 Resistance Temperature Detectors** — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

**268 Remote Reading Gages** — Eight-pp Catalog 291, revised, shows new

# Stop Corrosion
## in boilers, steam and return lines . . .
## with this Stickle deaerating feed water heater

SAVES STEAM
Vent Condenser releases only air and contaminated gases to atmosphere
NO CONTAMINATION
Counterflow of steam and water prevents reabsorption of oxygen
SELF-CLEANING
There is no need for removable baffles or trays

**Stickle Baffle Spray Type Deaerating Feed Water Heaters stop corrosion by removing destructive oxygen and carbon dioxide from boiler feed water . . . reduce fuel costs and boiler strain. Vertical and horizontal models. Capacity range: 3,000 to 300,000 pounds per hour. The latest development in more than 50 years of building feed water heaters.**

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designs in remote reading liquid level gages, including the Red Flasher Truscale. This has a scale which flashes continuously in red for a positive warning when boiler water level gets too high or too low. Profusely illustrated with photos and engineering drawings, catalog covers gages in four pressure groups from under 900 to over 1500 psi. Jerguson Gage & Valve Co.

### FUEL BURNING EQUIPMENT

**270 Oil and Gas Burners** — Bulletin OB-53 28 pp gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

**271 For Burning Refuse Fuel** — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

**272 Steam Atomizing Oil Burners** — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

### ELECTRICAL EQUIPMENT

**273 Testing Instruments** — Bulletin 19–57, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

**274 High-Power Batteries** — Bulletin CP-538/55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

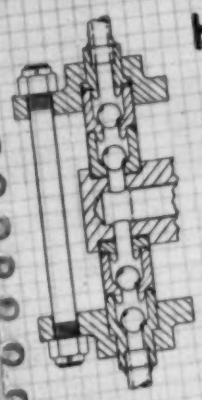
### MECHANICAL POWER TRANSMISSION

**277 Speed Reducers** — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

**278 V-S Drive Selection Tips** — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

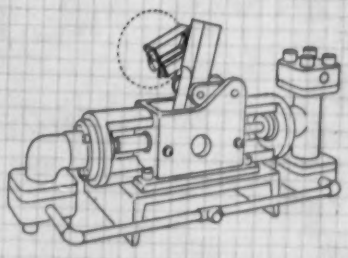

advanced design in high pressure pumps

High Pressure Valves--



of ball-guiding cone seat type. (Under high pressure conditions, balls do not seat themselves properly on conventional ring type seats, without guides.) Pressure drop is in direct ratio to ball rise (patent applied for). Valve illustrated is an easily disassembled design for pressures to 3,000 psi. Other valves, totally enclosed in forged steel, for pressures to 35,000 psi. Balls may be spring-loaded for down stream pumping and viscous materials (up to 30,000 SSU).

Differential Pressure Heads--



cut pump power requirements to a fraction by utilizing high suction pressures, when available.

These heads hydraulically balance the pistons using suction pressure. Thus, it is only necessary to power the pump for the difference between available gallon-pounds of suction and required gallon-pounds of discharge. Example: to add 5 gph of nitric acid at 5000 psig to 4500 psig liquid isotope—power requirement without differential pressure head is 2 hp., with differential pressure head it is only .5 hp., or a saving of 1.5 hp.

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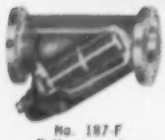
line strainers


No. 187-F
Bottom opening
type. 125 pound

No. 387
Top outlet type.
125 pound.

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Top outlet type
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OPW Line Strainers remove dirt, scale, rust and other solids from liquids flowing in any pipe line system. This positive screening-out process protects and prolongs life of pumps, meters, loading valves, and mechanical equipment. Pipe-snug fit of cage and screen, plus larger than pipe size screen area, assures *free* and *complete* flow of product through strainer. Screens can be quickly and easily removed for periodic check-ups, cleaning and replacement.

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**280 Internally Geared Power** — Featuring latest design improvements in gearmotors and embodying 60 multicolor illustrations, 16-pp Form F-1880 shows comparative advantages of gearmotors, lists ratings from ⅓ to 30 hp with gear ratios as high as 10:1. Cross-sectional details and enlargements of outstanding features are included, as well as a discussion of use of elliptoidal helical gears, and a chart graphing degrees of tempering of gear teeth. U. S. Electrical Motors Inc.

## PUMPS AND PUMPING

**281 Controlled Volume Pumps** — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

**282 High Pressure Pumps** — Eight-pp Catalog HP-1254 describes and illustrates company's Series HP controlled-capacity pumps for pressures to 35,000 psi and capacities to 2000 gph. Selection charts are provided for models with crank arm drive and yoke drive, along with application suggestions. Series HP pumps include some 208 models in three basic pump frame sizes for 2-, 3-, and 4-in. pump strokes. Specifications, design features discussed. Philadelphia Pump & Machinery Co.

## PACKINGS, SEALS

**285 Packings and Gaskets** — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

**286 Mechanical Seals** — Bulletin S-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service and application information, installations and engineering details. Crane Packing Co.

## OTHER EQUIPMENT

**289 Product Guide** — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure involved in the work. De Laval Steam Turbine Co.

**290 Preheating Combustion Air** — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also cov-


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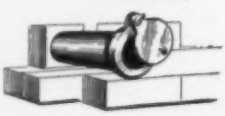
COMBUSTION
ACCESSORIES
*for Every Industrial Liquid Fuel-Gas Installation*

Air Control Door and Frame, top hinged, ratchet type, heavy duty, for manual control. Surfaces are machined to a close fit.

Fuel Oil Suction Strainer, single type. Large basket area insures low pressure drop; cover and basket easily removed for cleaning.

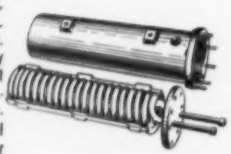
Wide-View Peephole, safety, curtain type. Cobalt glass removed to show bearing surface for curtain. Curtain halves are interlocked—open simultaneously.

Ignition Port with Refractory Tile No. M896 . . . for use with standard 3" pipe. Also serves as a peephole.



Furnace Relief and Access Door, heavy construction, practically air tight. Door casting correctly weighted, lined with plastic refractory retained by imbedded grill; with observation port and cover.

Fuel Oil Heater, Self-Cleaning, Spiral Coil Type. High oil velocity in coil, resultant turbulence prevents carbon formation. No internal connections or joints.



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ered in this informative booklet. Air Preheater Corp.

**291 Steam Condensers** — Advantages and features of company's line of steam condensers are detailed in this 24-pp catalog which pictures actual installations in typical power plants. Design data and an engineering section providing information on heat transfer rates, pressure drop, and other factors are included. Other sections cover air removal equipment, maintenance, and steam condenser specialties. Condenser Service & Engineering Co., Inc.

**292 Turbine Speed Control** — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

**293 Sectional Condenser** — Bulletin 131 shows benefits of sectional-design refrigeration condensers for 100 to 240 tons refrigeration capacity and explains their functions with diagrams and installation photos. A cutaway shows component parts. Niagara Blower Co.

**294 Heavy Duty Fans** — Eight-pp Bulletin 4824 describes new Airfoil centrifugal fans for heavy duty industrial applications. Discusses performance features and construction details of the fans. Text is supplemented with photos and drawings of wheel, housing, bearing, shaft. Several possible volume control methods that can be used with these fans are described and evaluated. Brake horsepower curves for four volume control methods are included. American Blower Corp.

**295 Corrosion Control** — Treatment of industrial equipment to control corrosion cannot be a hit-and-miss proposition, cautions this 6-pp folder. Examples are given of optimum control measures that may avoid costly, unsound treatment procedures, including minor physical or operating changes. Hall Laboratories, Inc.

**296 Precipitation Products** — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

**297 Burning Bituminous Coal** — This 24-pp illustrated booklet is a compilation of numerous actual case histories of industrial plants and institutions which burn bituminous coal "the modern way." Stressing operating economy achieved, these case histories show problems overcome, equipment used, and savings realized. Bituminous Coal Institute.

**298 Versatile Industrial Oil** — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)


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*key to modern industrial processes*

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Oxygen is one of the most important factors found in modern chemical and industrial processes. Whether to minimize product oxidation (prepared atmospheres, air infiltration, etc.) ... or to insure adequate oxygen for efficient combustion (boilers, kilns, etc.) ... or to control oxygen for proper process operations (ammonia, acetylene, air fractionation, etc.) oxygen control has become too important in today's operations for any profit-minded executive to overlook.

And because they are the *only* instruments that measure oxygen content directly, accurately and conveniently, Arnold O. Beckman Oxygen Analyzers have become the leading instruments for modern oxygen control in a wide range of applications—from catalytic refineries to cement kilns—from power plants to personnel protection.

These instruments (and systems) can be built to meet *your individual* needs.

**These instruments offer many unique advantages ...**

**SELECTIVITY:** Highly sensitive to oxygen. Effects of gases other than oxygen are negligible.

**HIGH ACCURACY:** 1% of full scale (Example: ±0.05% $O_2$ on range 0-5% $O_2$).

**MANY RANGES:** Full scale ranges from 0-1000 ppm or up to 0-100% $O_2$ available. Combustion ranges 0-5, 0-10, 0-15% $O_2$ supplied with 0-25% $O_2$ check range. Multi-range instruments available.

**RAPID RESPONSE:** Standard Analyzers—95% response in less than 1 minute. Special Units—95% response in 7 seconds!

**USE ANY RECORDER:** Millivolt output for potentiometers; current output for miniature electronic recorders and galvonometers; air output for pneumatic receivers and control systems.

**PACKAGE UNITS:** Analyzers and controls may be built into a cubicle with sampling components wired, piped, and ready for installation as a single unit.

**SAMPLING SYSTEMS:** Complete standard systems—components, package or portable units are available.

**OTHER ADVANTAGES:** Instruments may be mounted in explosion-proof cases, mounted indoors or outdoors, in portable panels, and have other desired features.

**Model F3:** Ranges of 0-1%, 0-5%, 0-10%, and higher. Meter on door for convenient readings at sampling point.

**Model G2:** Full scale ranges 0-0.1%, 0-0.5%, and others for low $O_2$ content. Ranges 90-100%, 95-100% $O_2$ for high $O_2$ content.

The above are but two of the complete line of Arnold O. Beckman Oxygen Analyzers available for every requirement.

*Send for helpful free literature which describes Arnold O. Beckman instruments in detail. When writing, outline your particular application—we'll gladly supply specific information.*

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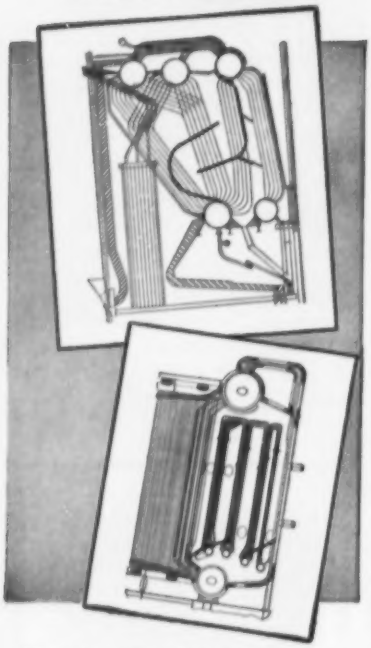

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## Electric System Design

*continued from page 95*

Net interchange of power on these interconnections is then compared to the scheduled interchange of power.

The difference, biased for any deviation of frequency from that scheduled, is computed and termed *area* requirement. This area requirement figure indicates the necessary governor adjustment so that area generation is equal to area load when the frequency is at the scheduled value. This governor adjustment is made by means of d-c impulses, initiated by and proportional to the area requirement, which are sent to the various controlled stations.

Adjustment of generation is accomplished by simultaneous action on all the controlled generators in conformance with their incremental cost characteristics. These characteristics are inserted into the control in the System Dispatching Office. This involves setting in a generation value for each station, referred to as a base point, corresponding to a selected incremental cost. These base points, together with the percentage participation of each station in generation changes above or below the selected incremental cost, comprise the intelligence required by the control to determine routing of the control impulses.

To help insure proper operation of the new control, several sessions were held previous to placing the equipment in service. At the time of this instruction, there did not appear to be a definition of *bias* which could be easily understood by the operators. As used in this system, bias represents the reaction on an interconnected system to a frequency change. This results from reaction of governors, reaction of customer load, changes in line loss, and other less significant reactions.

Because of all of these reactions there is a generation surplus when frequency is low and a generation deficit when frequency is high. The ratio of this surplus, or deficit, of generation to the frequency change is inserted as a bias into the load-frequency control. The control then continuously compares the actual system reaction with the reaction which is to be expected when governors are correctly adjusted to the customer load. The control, in this manner, determines the generation change necessary to effect this correct governor adjustment.

### Incremental Loading

Incremental loading of large power systems by manual or automatic methods like many other elements of system operation, requires a common sense approach. This aspect of system operation was discussed by Lester Le Vesconte and K. L. Hicks, both of Sargent & Lundy. They endeavored to emphasize the need for a sense of


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proportion in determining how far the refinements of economic loading should be carried on a particular system, and also presented a program to determine how incremental loading can be tailored to fit a particular system.

The step-by-step procedure which they recommended was first, to make a thorough survey of available data on the system. As a minimum requirement this data should consist of: 1, Heat rate curves for all major units from which incremental rates can be derived; 2, Fuel cost at each power station; 3, System load characteristics including daily load curves and annual load duration curves; 4, Present loading schedule; and 5, Transmission loss data if transmission losses are large.

Next in the program is an analysis of basic system characteristics, for example, the effect of the spinning reserve and its magnitude. The amount of spinning reserve is usually determined by considerations more basic to system operation than economic loading but the amount of spinning reserve used will determine the extent to which economic loading can be effective.

Another important fundamental characteristic is the spread in the incremental rates between units. This characteristic can have a profound effect on the method chosen for the application of economic loading. For instance, if the incremental rate spread is so great that the incremental rates of the units do not overlap, the units may be loaded in the order of increasing incremental rates, one at a time.

This type of system would need only the simplest method of incremental rate loading and would not require complicated methods or expensive equipment. If there is no spread in incremental rates, the solution is also simple. For example, groups of identical units will obviously be loaded equally to obtain optimum economic loading. Quite often the number of units which will be subject to incremental loading will be few compared to the total number of units on the system. The newest machines will be the largest and the most efficient, and it is possible that their incremental rates will be lower than most if not all of the older machines. Therefore, these newer machines will be base loaded.

There are some other not-so-obvious factors which should be rooted out in this preliminary analysis. Such simple things as fuel cost, for example, can present unlooked-for complications. Each power plant in a system will have a basic fuel cost which will differ depending on the relative location of the fuel source and the transportation facilities available. If all the fuel is purchased at a fixed price, no problem exists but this is rarely the case.

Quite often there are two fuels available at different rates, such as

*continued on page 124*

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## Electric System Design

*continued from page 123*

coal and dump gas in the summer time. In general, the incremental price should be used but in certain cases this will lead to difficulty.

In one actual case a rather large but limited amount of fuel was available at about ⅓ the cost of a higher priced fuel. If the incremental cost for determining the plant loading is calculated using the higher price fuel, the kwh production of this plant will be reduced to a point where not all of the inexpensive fuel will be used. On the other hand, if the lowest fuel cost is used for calculating the incremental rate, the results will indicate that the plant should be base loaded.

Obviously, neither of these answers is correct. All the cheap fuel should be used up and the loading, in addition to the kwh generated by the cheap fuel, should be regulated according to the higher incremental rate. This presents a complication and an important consideration in the choice of a method of applying incremental loading.

### Theoretical Savings

The next step in the procedure is an economic analysis to determine how much effort and expense can be justified in the pursuit and acquisition of an economic loading method. Here, it is first necessary to determine how the system would have operated had the method of economic loading not been applied. Following that, the next step is to consider how the system would be loaded incrementally neglecting the effect of transmission losses or limitations in the transmission system.

Quite often it is desirable to know whether the savings which can be derived from incremental loading can be increased appreciably by adding the effects of incremental transmission losses especially if the transmission losses are a major factor on this system. This is an interesting comparison to make because frequently the more expensive methods of economic loading are necessary only when incremental transmission losses must be included.

This analysis requires calculating the most economical loading of the system both with and without the effect of incremental transmission losses and comparing the cost of operation of the system both ways. To analyze even a typical year represents a lot of work.

The methods of application of incremental control are divided into two major classes. The first provides an indication of the proper loading for the dispatcher to use, while the second, as already described, controls the outputs of the units automatically to follow economic loading.

One of the methods in the first category is the use of precalculated loading curves. A set of curves must be available for each combination of units in service, and all these curves must be recalculated each time a change in fuel cost occurs. If transmission losses are to be included, the calculation of the loading curves becomes much more complex and they must be recalculated for changes in the transmission system as well as changes in fuel cost.

If changes in fuel costs occur frequently, another method, the incremental rate slide rule, is much more flexible.

Another type of device has been developed which will convert telemetered plant outputs and stored information on transmission loss characteristics into either an incremental cost of power delivered to the load, or a direct indication of desired generation schedule, thus supplying the dispatcher with a continuous up-to-the-minute analysis of system operation from which he can easily determine which machines should pick up or drop load.

### Transition to Higher Voltages

An aspect of electric system operation that is occupying the attention of electrical engineers not only in the U. S. but in other countries as well, is the need for higher transmission voltages. In this country the


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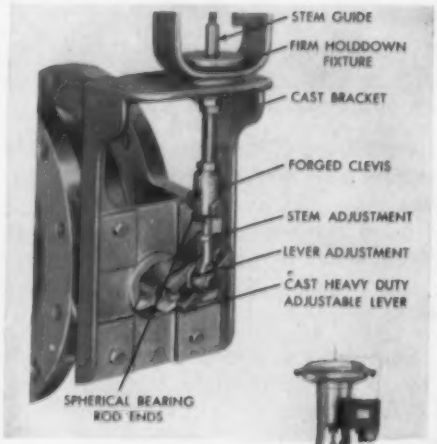


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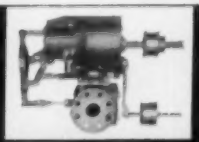

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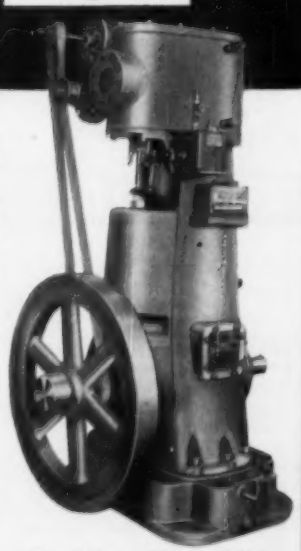

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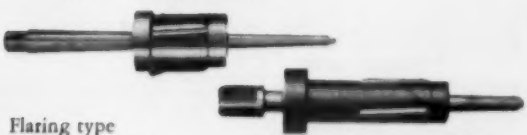

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highest transmission voltage in use is the 345 kv used both on the lines of the American Gas & Electric system and on the Bonneville system in the Northwest. In Europe, however, 400 kv systems are in use both in Sweden and also in Russia, and in those countries much higher voltages are under consideration.

In both of those countries the extra high voltages are dictated by the very long transmission distances involved but in the U. S. the high load concentrations require high voltage to effect more economical transmission. As pointed out by E. C. Starr, Chief Engineer of the Bonneville Power Administration in his discussion of this subject at the American Power Conference, for the blocks of power that are certain to be encountered in the future, *even though the distances may not always be great*, still higher voltages, and possibly direct current will be required for best performance and economy.

### High Voltage in Sweden

Of great interest was the paper on the use and development of extra high voltage transmission in Sweden presented by Gunnar Jancke, Chief Engineer in Charge of Research and Development of the Swedish Power Board.

The first sections of a superimposed 400-kv system were placed in service in the spring of 1952. This network now consists of 1700 miles of lines and 4500 mva of transformers. The experience with the 400-kv network is entirely satisfactory. Transmission costs are about 40 per cent lower than at 230 kv. By 1980, however, studies show that, then, it will be necessary to transmit 8000 mw over an average distance of 500 miles; it will be necessary to go to still higher voltages, and the present 400-kv lines have been so designed that they can be used for 500 kv without raising the insulation level, after being reinforced by a third conductor in the bundled conductors.

Comments on Power Supply and Automation in Detroit will be presented in a subsequent article.


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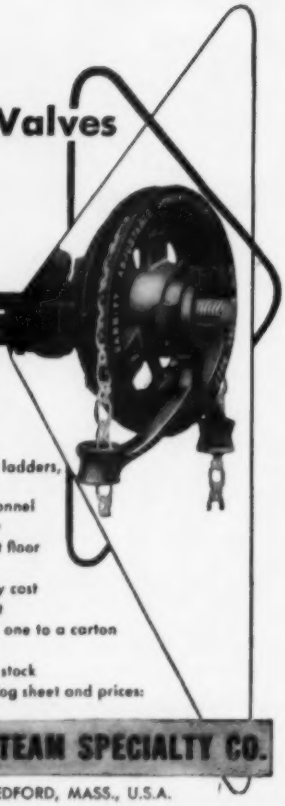

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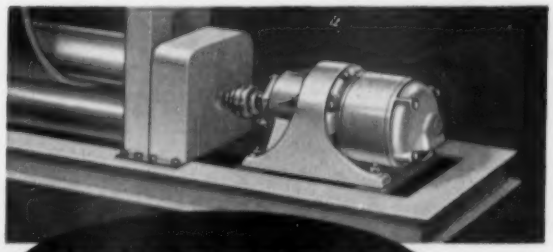

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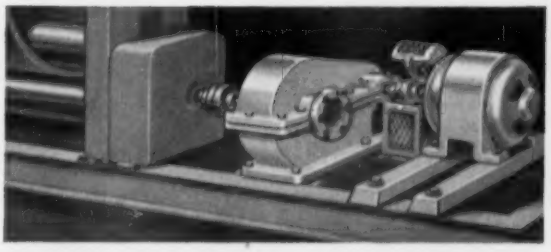

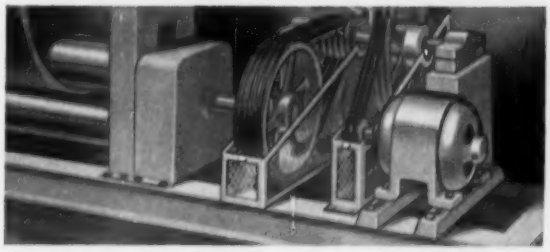

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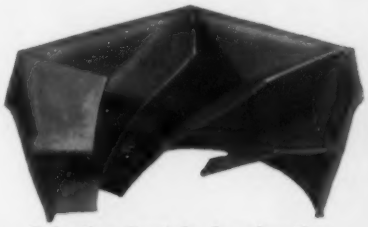
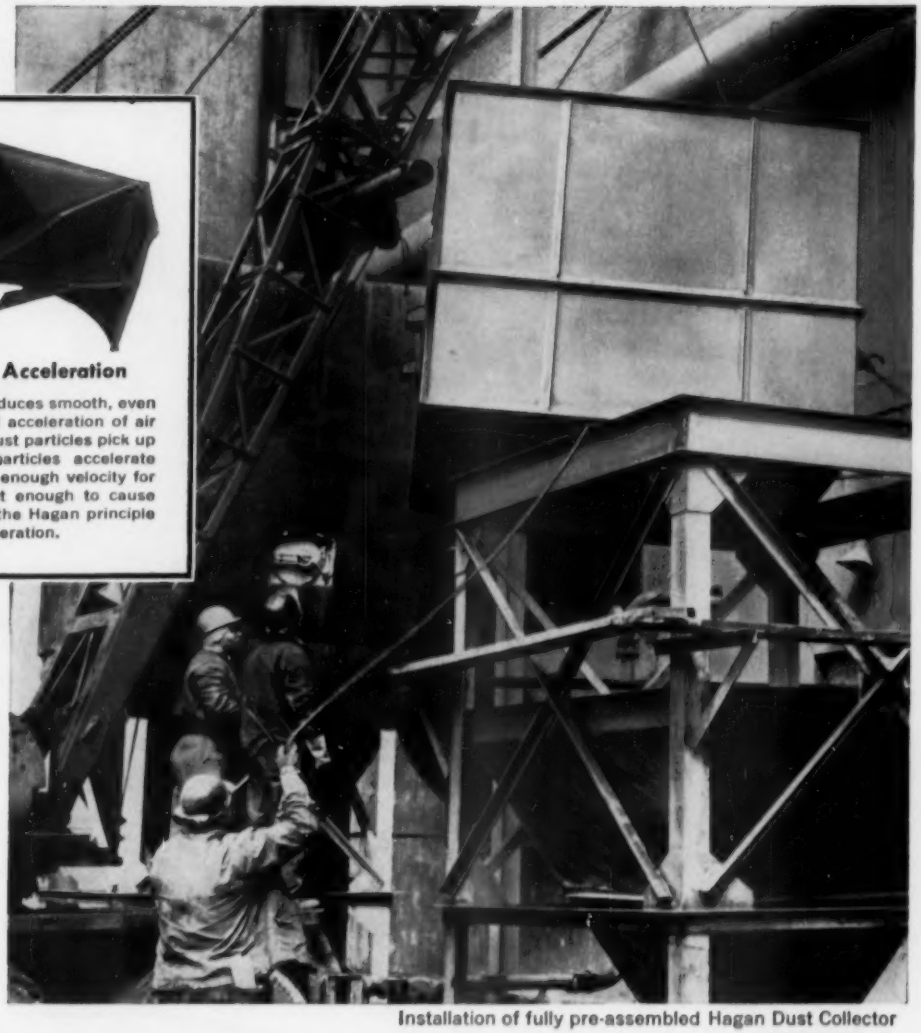


**Selective Particle Acceleration**

Inlet cell vane design produces smooth, even deflection and controlled acceleration of air stream. Smaller lighter dust particles pick up speed quickly, larger particles accelerate more slowly. Both attain enough velocity for good separation, but not enough to cause erosion damage. This is the Hagan principle of Selective Particle Acceleration.



Installation of fully pre-assembled Hagan Dust Collector

## Minimum erosion, fast installation...

# HAGAN MECHANICAL DUST COLLECTOR

Fast installation is one of the features of the new Hagan Dust Collector. Recently a collector for a 75,000 lb/hr boiler was erected in less than fourteen hours. With the duct work connected up, it was ready to go.

The Hagan vaned-nozzle inlet design has practically eliminated tube erosion and collection efficiencies are raised, because of high effectiveness in the 1 to 10 micron range. Check these cost and trouble-saving features:

- Tube erosion virtually eliminated. Hagan Dust Collectors are *guaranteed* against tube failure due to erosion *for two full years.*
- Pressure drop 20% lower than conventional multiple tube collectors based on same efficiency.
- Hexagon shaped tops—This honeycomb shape permits close tube packing, eliminates dust trapping and clogging.
- Easy maintenance—Ease of access to all parts makes the Hagan Dust Collector easy to inspect.
- Lower overall height requirements.

Add to these the fact that the Hagan Dust Collector's efficiency easily meets the most rigid existing code requirements for coal fired boilers for any city in the United States.

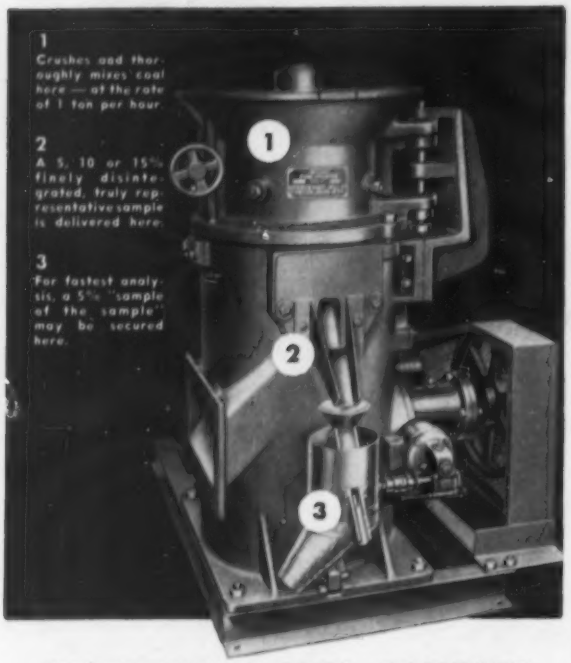
Write for specifications, or a Hagan engineer will be glad to discuss your particular requirements.

**HAGAN CHEMICALS & CONTROLS, INC.**

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES

For more data circle 580 on Post Card

# Samples Coal Shipments in a Matter of Minutes!


1
Crushes and thoroughly mixes coal here — at the rate of 1 ton per hour.
2
A 5, 10 or 15% finely disintegrated, truly representative sample is delivered here.
3
For fastest analysis, a 5% "sample of the sample" may be secured here.
1
2
3

## STURTEVANT COAL SAMPLER

### with New Automatic Splitter

**It's a fact!** Big users of coal and coke know the true B.T.U. value of deliveries before moisture has a chance to evaporate . . . thanks to the speedy crushing, homogenizing and proportioning actions of the Sturtevant Automatic Coal Sampler and its Automatic Splitter. So, they get what they pay for . . . and increase boiler efficiency in the bargain.

**Handles a ton an hour!** The Sturtevant Automatic Coal Sampler takes 3" or smaller coal or coke and crushes it to 6 mesh or finer. Sample spout takes off 5, 10 or 15% of the finely crushed homogenous mixture, as desired. Then, the optional Automatic Splitter takes a 5% "sample of the sample."

**"OPEN-DOOR" DESIGN**

provides "One Man, One Minute" accessibility for all cleaning and maintenance — an exclusive Sturtevant feature that saves valuable down-time.

***Want more information?*** *Write for all the facts about the Sturtevant Automatic Coal Sampler — the tested shortcut to accurate B.T.U. analysis.*

# STURTEVANT

**MILL COMPANY**

**143 Clayton St., Boston 22, Mass.**

CRUSHERS • GRINDERS • MICRON-GRINDERS • SEPARATORS
BLENDERS • GRANULATORS • CONVEYORS • ELEVATORS

**For more data circle 581 on Post Card**

## CHARCO

## HIGH VOLTAGE PROTECTIVE EQUIPMENT

Charleston Rubber Company leads the field in manufacture of superior protective products for linemen and high voltage workers

## *Send for your copy NOW!*

**NEW 32-PAGE CATALOG OF LINEMEN'S PROTECTIVE EQUIPMENT**

This new illustrated catalog, for use in public utility and industrial electrical fields, illustrates many products and gives concise instructions on proper care and use

**POSTPAID BY RETURN MAIL**

***Also*** **28-PAGE ILLUSTRATED CATALOG OF INDUSTRIAL PROTECTIVE GLOVES, APRONS, SLEEVES, DANGER FLAGS, AND OTHER SAFETY EQUIPMENT**

Please specify which catalog you desire.

CHARLESTON CHARCO SERVICE FOR SAFETY RUBBER CO.

## CHARLESTON RUBBER COMPANY

**45 STARK IND. PARK CHARLESTON, S. C.**

**For more data circle 582 on Post Card**

# The Inside Story of

# CHAPMAN

## Motor Units

### For Valves, Floorstands and Sluice Gates

The exposed view gives you the facts. On a Chapman Motor Unit there are approximately half as many parts as with any other make. This is engineering sense. The fewer the parts the fewer the headaches. The less complicated the unit the less you pay for maintenance.

This simplification in design is all on your plus side. You lose nothing in performance. In fact you get smooth accurate performance over a *longer* period of time. There's no drift. Backlash is low. And seat tightness is held at any predetermined level by precise micrometer-controlled limit switch.

Installation is easy and economical. When used with floorstands they come completely wired at factory . . . ready for your line. They're weatherproof. They're *steam tight*. And they operate at any angle. Rugged stub-tooth gears require no grease or oil.

See our Catalog 51, now. If you've misplaced your copy write for a new one, today.

**THE CHAPMAN VALVE MANUFACTURING CO.**

**INDIAN ORCHARD, MASSACHUSETTS**

For more data circle 583 on Post Card

**HOW TO SELECT WATER-CONDITIONING EQUIPMENT** (NO. 2 OF A SERIES)

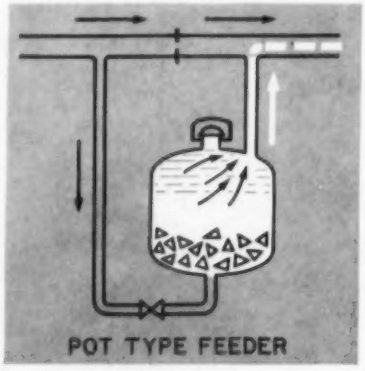
# Chemical Feeders

Practically all water-treatment systems include addition of chemicals for one or more purposes: as coagulants to adsorb color, organic matter, oil and turbidity; to raise or lower pH; for lime softening; to inhibit corrosion; to kill bacteria; to adsorb tastes and odors.

The method of feeding the chemicals depends on the kinds used and on the volume, accuracy and proportions required. In general, solution feeders are used for smaller dosages and chemicals which can't be fed dry; dry feeders for large dosages. Here are some of the most-used types of feeders:

### Pot type feeders

These are used for slow-dissolving chemicals in crystal or lump form (alums, sal soda, etc.) or special briquets. The chemical is placed in the feeding pot where it is dissolved by by-pass water flowing from the high-pressure side of an orifice to the low-pressure side. Since this flow is proportional to the main flow, the amount of chemical fed is proportional. Variations in amount and solubility of the chemical can, however, affect the feed rate.

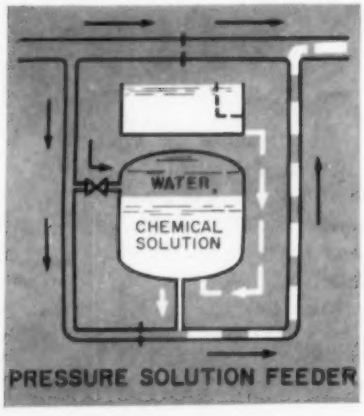


POT TYPE FEEDER

### Pressure solution feeders

These allow use of lower cost chemicals (aluminum sulfate, soda ash, etc.) than pot type feeders and provide more accurate control. The chemical is dissolved in the open tank. When needed, the solution is charged into the bottom of the pressure tank, and the displaced water, being lighter, flows out the top to waste. A sight glass float shows the level of the chemical solution in the pressure tank. When on the line, the feeder feeds from the bottom.

Note that solution feed is into a by-pass circuit instead of directly into the raw water line. This eliminates a long vertical run of undiluted solution which, because of its greater weight over the water in the circuit, could affect proportional feeding accuracy.



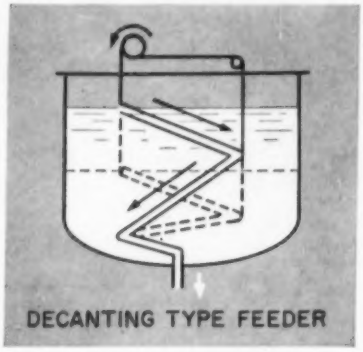

PRESSURE SOLUTION FEEDER

### Gravity orifice feeders

A solution of known concentration flows through an adjustable orifice under constant head to provide the desired rate. For intermittent feed, a solenoid valve on the orifice discharge line is operated simultaneously with a raw water pump. Low in cost but limited to constant water flow rates and clear solutions that will not clog the orifice.

### Decanting type feeders

This type is known as Permutit Electro-Chemical Feeder. A swing draw-off pipe is lowered at a speed that draws off solution at the desired rate. Feeds practically any type of solution or slurry used for water treatment.



DECANTING TYPE FEEDER

For proportional feeding, a water meter operates a timer that starts the feeder motor which lowers the draw-off pipe for a pre-set period. The timer controlling the lowering rate is easily adjustable allowing wide flexibility and accurate control. Rugged construction. Available with mixing propeller and with cover and dust evacuator.

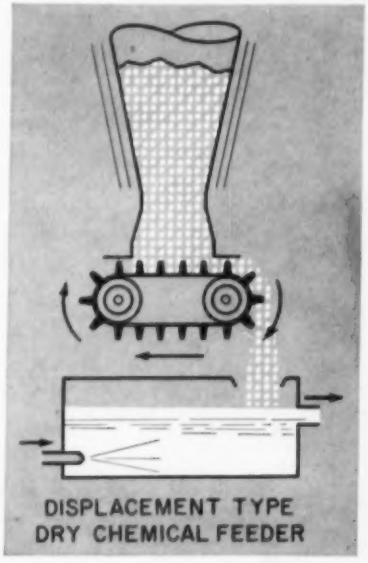
### Reciprocating pumps

Pumps with adjustable length of stroke are widely used as feeders . . . generally operated by a meter and timer. Since volumes fed per stroke are uniform, feeding is accurately controlled.

A duplex or double pump feeds one solution to 2 or more points . . . or 2 or more solutions to the same or different points . . . in adjustable proportions.

### Dry chemical feeders

A displacement type dry feeder eliminates batch weighing or measuring of dry chemicals and delivers a constant flow of accurately measured amounts of dry chemical (by volume) to a mixing chamber through which water flows at a sufficient rate for good mixing and to prevent settling.



DISPLACEMENT TYPE DRY CHEMICAL FEEDER

The chemical is discharged from a vibrated hopper onto a moving belt with lugs which "slice" off equal, exact volumes of the dry material. The belt speed is adjustable to deliver from 0 to hundreds of lbs. per hour by simple setting of a stepless speed changer. Adjustable while feeder is running, if required.

The feeder can be designed for constant rate feed or, with a meter and timer, for proportional feeding. Feeds practically any type of non-deliquescent dry powder or granules. Can be equipped with counter to show cumulative amount of chemicals fed.

• • • •

For complete details on feeders or other types of water-conditioning equipment, write: The Permutit Company, Dept. PE-5, 330 West 42nd Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

**PERMUTIT®**

*rhymes with "compute it"*

Water Conditioning

Ion Exchange • Industrial Waste Treatment

For more data circle 584 on Post Card